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ANNALS of SURGERY

A Monthly Review of Surgical Science and Practice

Edited by
LEWIS STEPHEN PILCHER, M.D., LL.D.
of New York

With the Collaboration of
SIR WILLIAM MACEWEN, M.D., LL.D. of Glasgow
SIR W. WATSON CHEYNE, C.B., F.R.S. of London

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ANNALS of SURGERY

VOL. LXIX JANUARY, 1919 No. 1

A NOTE ON THE TREATMENT OF COMPOUND FRACTURES OF THE SKULL WITH OPEN DURA

By ERNEST SACHS, M.D.

OF ST. LOUIS, MISSOURI

ASSOCIATE PROFESSOR OF SURGERY IN THE WASHINGTON UNIVERSITY SCHOOL OF MEDICINE

THE treatment of fractured skull is a subject on which there still is considerable difference of opinion. Surgeons differ a good deal as to which cases should be decompressed and in which cases operation offers no prospect of relief. There is a group of border-line cases which frequently recover without operation, but whose symptoms are more quickly relieved by operation. In some of these cases operation obviates permanent disability due to persistent headache. With all such cases this paper does not concern itself.

Compound fractures of the skull in which the dura has been torn and the brain has been traumatized have always offered a grave prognosis and operation has always been considered serious because of the possibility of meningitis or a brain abscess.

The problem has received a new stimulus, however, since the reports have come in about the modern treatment of war wounds, especially since we have recognized the difference between contaminated and infected wounds. It seemed reasonable that these views which had been applied to wounds elsewhere in the body could also be applied to wounds of the brain. We were further encouraged in this view by attempts in the laboratory to produce brain abscesses. Repeated attempts to infect healthy brain tissue with virulent pyogenic organisms failed to produce abscesses. It was realized that devitalized tissue was probably an important factor in bringing about brain infection. Suitable cases for this work are rare in civil life as compared to the huge number of cases encountered among war wounds. Certain differences are furthermore apparent between these cranial wounds of civil life and those occurring on the battlefield. In a large percentage of cranial war wounds with open dura, foreign bodies are lodged in the brain substance, while in fractures occurring in civil life this is very rare. The injury, furthermore, in the latter type of cases, is more apt to involve the cortex and subjacent area but does not extend very deeply into the brain.

In discussing this subject with the medical officers stationed in St.

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Louis in the fall of 1917 and the winter of 1918 for instruction in neurological surgery, I advocated the excision of all traumatized tissue, scalp, dura, and brain tissue and replacing the defect in the dura by a transplanted piece of fascia and closing the skin completely without drainage. During the past year I have had opportunity to apply this method in two cases. The results have been so satisfactory that they seem worth reporting.

CASE I.—J. C. (No. 12,667, Children's Hospital), Milton, Illinois, age, seven and one-half years, admitted April 16, 1918. Discharged May 22, 1918.

April 15th, 1 P.M., was injured while driving a horse. When picked up by a physician he was conscious and crying. Over the right temporal region there was a ragged incised wound from which brain tissue was oozing. Taken three miles to nearest town, and there began to vomit. He became violent at 6 P.M., so that he had to be restrained. No paretic symptoms noted by his doctor. No speech disturbance. Had not voided since accident. Patient admitted to the hospital 9:30 A.M., April 16th. My note on admission was as follows: Boy conscious and rational. Sensorium clear. Lacerated wound, two inches long, over right parietofrontal region. No tremor of either hand. Abdominal reflexes normal. K. K. hyperactive. On the right side, Babinski; a questionable one on the left side. No other evidence of cerebral involvement. Must be treated like contaminated wound. Great danger of meningitis but at end of twenty hours it still may be cleaned out.

Ophthalmological Examination.—Vessels very full and slightly tortuous. Vessels on left side show a blurring of edges. On right side vessels not so full. Fifteen hundred units tetanus antitoxin given.

Operation.—Edges of wound excised. Incision carried back so that skin flap might later be swung over the defect. Stellate fracture. One piece of bone deeply driven in. This piece was removed, and the edges of the exposed bone rongeured away. Profuse diploic bleeding controlled by wax. Tear in dura 2½ cm. long. Edges contused. Dura opened widely, exposing lacerated pulpy brain tissue. All this area excised down to normal cortex and edges of dura removed. Fascia lata inserted to replace defect in dura. This sewed in with interrupted fine silk. Skin-subcutaneous flap swung over, galea closed with interrupted silk. Silk for the skin. Posteriorly, an area over the intact skull, 1 cm. in diameter, was left to heal by granulation. This was well away from the defect in the skull. Small rubber tissue drain diagonally placed. Drain removed next day. Wound healed uneventfully. Patient discharged May 22, 1918.

November 29th: Patient's physician reports that patient is perfectly well.

CASE II.—I. S. (Sur. No. 6063, Barnes Hospital). Age, fifteen years. Chesterfield, Missouri. Admitted August 21, 1918. Discharged September 15, 1918.

When patient was admitted this history was obtained:

Patient kicked by a mule over left parietal region about two hours before. Large ragged wound of scalp with pulped brain tissue exuding. Skull under this area can be felt to be crushed into numerous small pieces. Patient deeply unconscious; blood-pressure systolic 140. All reflexes abolished with the exception of ankle clonus and Babinski on right foot. Immediate operation undertaken.

Operation.—Vertical incision from zygoma on left side to median line over longitudinal sinus with excision of edges of skin wound. Brain tissue oozing out constantly. Several large bone fragments had been driven into the brain. These were removed. Dura badly lacerated. Edges of dura excised and all the pulped brain excised down to normal brain tissue. A knife used for this purpose. Considerable hemorrhage from a large vein at the bottom of a sulcus. This stopped with a silver clip. A piece of muscle placed over this point. The defect in the dura was closed with a piece of fascia lata which was sewed in place with interrupted silk sutures. Wound dry. Tear in temporal muscle repaired, galea and skin closed with interrupted silk. No drainage. The area of brain removed lay in the precentral area over the face and arm center and encroaching upon the leg center.

Next day, patient began to raise his right arm a little and spoke a few words very incoherently.

Sutures out on the third day. Primary union. Gradual return of power in arm and leg and is beginning to talk a little. Has a partial motor aphasia.

Patient was discharged September 15, 1918. Since then, patient has continued to improve. He has a paresis of his arm and leg but walks about and is using his hand. His speech is improving continually.

The most successful series of gunshot wounds of the brain is reported by Cushing, in Vol. v of the *British Journal of Surgery*. He advocates the use of a rubber catheter attached to a suction apparatus for cleaning out the track of the bullet and removing bone fragments and devitalized brain tissue. In the types of cases here reported such a technic would not seem practical since the area traumatized is a large but comparatively shallow one.

[EDITOR'S NOTE.—The reader will compare with these case reports of Dr. Sachs the practice at La Panne Hospital in Belgium as given by Dr. Janssen, for which see Editorial Comment, p. 61.

A SOURCE OF ERROR IN INTERPRETATION OF RÖNTGENOGRAMS OF THE SKULL

By Sherwood Moore, M.D.
of St. Louis, Missouri
Assistant in Surgery and Director of the Actinographic Laboratory, Washington University Medical School; Röntgenologist to the Barnes and Children's Hospitals

In the November, 1918, number of the Annals of Surgery, Merrill Miller and E. G. C. Williams of Danville, Illinois, present an article, illustrated with four X-ray plates, entitled "A Radiolucent Shadow Occurring as a Constant Factor in Cases of Severe Intermittent Headache." A study of the article and the four reproductions of plates leads to the belief that the semilunar shadow demonstrated is identical with a like shadow found in a large proportion of all the head plates made in the X-ray Laboratory of the Washington University Medical School. This condition was first noted about June, 1917, and dates from the time when the method of making plates of the skull was changed by the employment of a then new plate-holder. Coincidentally, the clue to the explanation of its occurrence was furnished by these three facts: That it was not observed in plates made by the method previously employed in the laboratory nor in single plates made without using a plate-holder, and that it *was* observed in plates made with the plate-holder to be described later. The shadow has been found in all of the stereoscopic plates which can be described as technically good, in the two hundred and fifty-five (approximately) patients röntgenographed in the laboratory since the date mentioned. These cases cover the range of the various conditions for which röntgenological examination of the skull is considered desirable. In other words, the cases varied from normal to the gross pathological, and the shadow was shown consistently in all types of cases. There was occasionally found also another semilunar shadow, and still others circular in shape, all alike in *quality* to the one described by Miller and Williams.

These shadows have given rise to considerable confusion. Two cases occurring in this city are quite convincing that their incorrect interpretation is fraught with most disastrous possibilities. In one, this dark semilunar shadow was diagnosed as an intracranial hemorrhage, apparently without consideration of the fact that trauma resulting in such an extensive hemorrhage would doubtless have produced symptoms sufficient to have rendered a röntgenogram unnecessary for diagnosis; furthermore, the fact that hemorrhage would produce radiopacity rather than radiolucency was ignored. The shadow in the other case was considered as due to the presence of air in the skull, a more reasonable interpretation on purely röntgenological grounds than the one preceding, but most illogical in the absence of a history of injury sufficient to have caused air

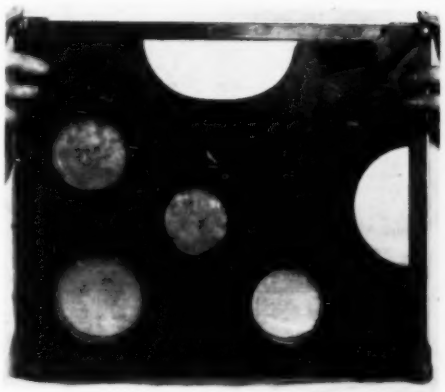

FIG. 1.—Base of cassette.

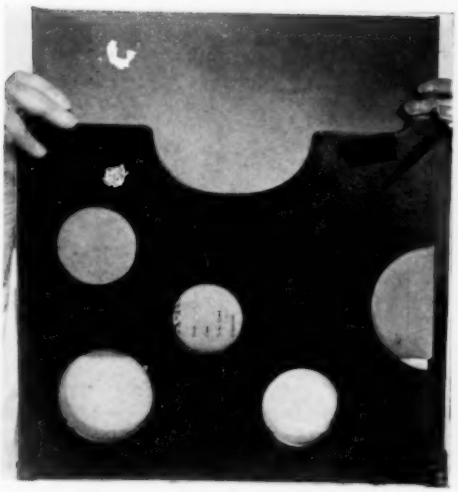

FIG. 2.—Base of cassette, showing plate partially inserted.

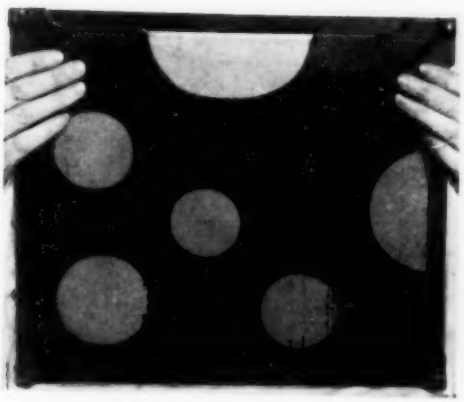

FIG. 3.—Base of cassette, showing X-ray plate in position in cassette.

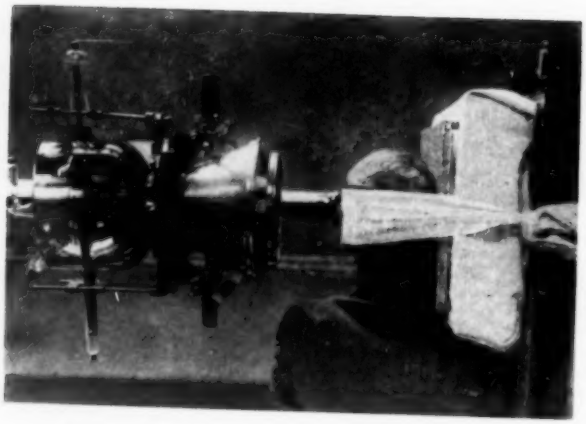

FIG. 4.—Showing portion of tube, patient and cassette.

FIG. 5.—Showing a semilunar radiolucent shadow.

FIG. 6.—Semilunar shadow absent.

FIG. 7.—Semilunar shadow absent.

to collect in the skull. The possibility of harmful results proceeding from these interpretations of the shadows prompts the reporting of the true cause of their occurrence.

In making röntgenograms of the head, and in all cases where the stereoscopic method is employed, it is necessary that a plate-holder, or cassette, be used in order to secure an unchanging position for the X-ray plates for the two exposures. A widely used, seemingly the only cassette on the market, is one as illustrated in Figs. 1, 2, and 3, which are views of the under side. This under side, or base, of cast iron, has two semilunar areas cut out to facilitate the insertion and removal of plates. There are also three circular areas presumably for decreasing the weight of the cassette. The top is a thin sheet of aluminum tightly stretched. It will be seen at a glance that the cassette can only be conveniently used with the larger of these semilunar spaces located in such fashion that it underlies the vertex of the skull and corresponds in location and curvature to the semilunar translucent areas in the X-ray plates described by Miller and Williams. The outlines of the other deficiencies in the base of the cassette have frequently appeared on the X-ray plates made in this laboratory, but not with the same consistency. Now, were the semilunar shadows shown by Miller and Williams due to an intracranial condition, according to the hypothesis offered by them, namely, the resultant of hydrostatic changes in the cerebrospinal cavity, it would seem reasonable to suppose that the position of the shadows in the X-ray plate of the skull would remain constant in relation to the glabella and inion. However, study of the four plates presented by the writers shows the semilunar shadow shifted anteriorly or posteriorly, as the head was extended or flexed on the neck. This would have been an excellent clue to the explanation of the phenomenon had it been observed. The semilunar shadow in all four of their plates occupies a different position in relation to the coronal plane of the head.

To demonstrate that the findings of the authors are due to the plate-holder employed, the following experiment was made. A healthy subject without history of previous injury, headache, etc., was selected, and röntgenograms made in a manner to be described. Fig. 4, a photograph, shows the position of the patient, cassette, and X-ray tube. Plate made in this position in the usual way, gas tube, focal-plate distance, 24″, 60 k.v., 35 m.a., exposure 10 seconds (Niedner timer, Fig. 5), shows the semilunar radiolucent shadow under discussion. A second radiograph was made with a plate of lead inserted in the cassette between the cast iron base and the X-ray plate, all other factors remaining constant. The radiograph shows an entire absence of the shadow in question (Fig. 6). A third radiograph was made without the use of either the cassette or the plate of lead, the X-ray plate resting only on a sheet spread over a wooden block. It will be seen, again, that the semilunar shadow is absent (Fig. 7).

The behavior of the X-ray plate in the cassette in question has been

proven out in this laboratory numbers of times, and there is no doubt that this shadow so frequently seen in head plates is due to the construction of this most commonly used cassette. In short, the semilunar translucent area can be produced at will in a given subject. The makers of this piece of apparatus seem to have ignored a principle almost axiomatic among the older generation of röntgenologists, namely, that radiograms should be made with the X-ray plate supported on a uniform surface, preferably wood. Metals give off secondary characteristic radiations (when exposed to X-rays) and these diminish the clarity of the plate, hence their use as a plate support is to be avoided. Iron produces these secondary radiations in a high degree.

Now, this radiolucent semilunar shadow can be more readily demonstrated as due to the cause set forth than the phenomenon can be explained. Radiolucency naturally comes from an increased reduction of the silver salts in the emulsion on X-ray plates. This reduction, in a limited area, in turn, must be due to the increased amount of rays acting thereon, as compared with the remainder of the plate. The secondary radiations from the cast iron base (iron stands high as a producer of secondary rays) of the cassette acting through the glass of the plate and on the emulsion would naturally lead to the belief that the points at which the plate is supported by the iron would be the darker, which, however, is the reverse of the case; therefore, it would at first appear that either the iron gives off characteristic radiations that neutralize the rays coming from the X-ray tube and the secondary rays arising from the head itself, or, the iron possesses a capacity for absorbing such radiations in greater degree than does air, which is the only substance at the back of the plate where the radiolucent area appears. Nevertheless, this does not explain why the outlines of the small circles in the base of the cassette are not more constantly shown in radiographs of the skull. Considering the phenomenon from all aspects, one is compelled to draw the conclusion that it is extremely complex, depending on the following factors and their interrelations, namely, the action of:

The direct rays from the X-ray tube modified after their passage through the skull;

The " scattered " and characteristic radiations arising from the head;

The " scattered " and characteristic radiations from the aluminum top of the cassette;

The " scattered " and characteristic radiations and coefficient of absorption of the same (arising from the superimposed substances) by the iron base of the cassette;

These same properties in the air at the point where the plate is not supported by the iron base; and finally,

The varying distances (in different planes of the head) traversed by the rays.

However, we are only interested in this question from the practical

röntgenological point of view, and the explanation of why this phenomenon takes place would have to be worked out by the physicist. Suffice that it is proven that the radiolucent semilunar shadow is due to faulty apparatus and is of no clinical significance.

In conclusion, it should be pointed out that structural change in the organism capable of producing radiographic findings as striking as the shadow discussed must rest on a foundation of known pathology. When bizarre and unusual X-ray shadows are encountered one should always consider these two questions:

Can the shadow be due to extraneous causes?

Is there a pathological explanation for its occurrence?

THE SURGICAL TREATMENT OF CANCER OF THE SUPERIOR MAXILLA*

By Winfield Scott Schley, M.D.
of New York

The results of operation for cancer of the upper jaw have not shown a large percentage of cures, judging from collected cases in literature. This is due to several factors—the great malignancy of these growths, especially the squamous-celled carcinoma; the late stage at which so many present themselves, not infrequently owing to wrong early diagnosis; and *very largely* to an incomplete primary operation. Removal of the superior maxilla is an operation still too infrequently done. Its apparently formidable character, with seemingly inevitable disfigurement, causes both surgeon and patient to hesitate. A number of cases are turned down as inoperable which are not especially difficult of operation, and which when operated upon later have given cures over a considerable period of time (five years and three and a half years) and are still apparently well. One such case I am able to show this evening; another (well nearly seven years after the last of two fairly prompt local recurrences) has been heard from recently.

Cancer of the upper jaw, and especially in the maxillary antrum, fortunately remains a *local* disease until comparatively late; nor does it tend to metastasize to the degree of cancer elsewhere. Glands appear under the jaw and in the neck only as a late stage in carcinoma and almost never in sarcoma. The great majority of recurrences are *local*. Glands in the neck in addition to the primary focus in the jaw are not always a contra-indication to operation; and I have seen such cases after a thorough neck dissection from below up, keeping wide of the involvement, remain free of any further neck invasion for three years, and not develop at all subsequently even when local recurrence towards the orbit or pterygoid region occurred. It created a distinct lymphatic block—a matter to be considered in all operations for malignant disease, and especially in that of the mouth and jaws.

The primary operation must be thorough and well beyond the appreciable limits of the disease, as recurrences are often infinitely more difficult, and at times impossible, to deal with; and by delay valuable ground and time are lost. Here, as elsewhere, our results are directly proportionate to the care exercised upon first attack and to extent of field of operation. It is amazing how much can be done (and with so little reaction, as blood loss is small) with external carotid ligation or compression. I have several times actually seen blood loss as little as four ounces, by careful estimate. In upper jaw involvement we do not interfere with the muscles of deglutition as in the removal of the lower jaw, and have not that added source of danger. In the

* Read before the New York Surgical Society, December 11, 1918.

upper jaw as in the lower, carcinoma is more frequent than sarcoma. Giant-celled sarcoma here as elsewhere gives a better prognosis. Two of the cases alive and well to date were of this type, and are here this evening. (One had her first operation of partial resection nearly twelve years ago and has had five very local recurrences.) If the growth is confined to the superior maxilla alone, or with the nares, the problem is greatly simplified. With surface or deep extension towards the soft palate and faucial pillar, or involvement of the orbit or skin of the face, the difficulties are considerably increased; yet this was the condition of the first case of the small series presented, now alive and well nearly seven years after the last of two recurrences of squamous-celled carcinoma. Where the disease has invaded the pterygoid muscles and sphenomaxillary space the condition is hopeless.

The operability of the disease is not always easy to determine. It is not invariably its extent that must determine this point. Its variety, malignancy (so far as determinable), chief situation and apparent and probable direction of extension, and condition of the patient must all be weighed. Within my own experience and my observation of the work of others in this country, patients have always stood the operative work very well—better than one would expect. On the average they can be raised up in bed on the third day and are out of bed on the seventh or eighth. As has been said, glandular involvement in itself, if not extensive, is not a contra-indication to operation.

Preparation for operation is important. Where necessary or advisable the hæmoglobin should be increased and the general condition of the patient should be improved as much as possible during the time it is considered wise to wait. Mouth cleansing, especially with tumors involving the alveolar border, hard palate or buccal mucosa, must be thorough. Good skin cleansing and disinfection of the face insures rapid and accurate primary union of the flap. Preliminary ligation or compression of the external carotid at or above the superior thyroid artery reduces hemorrhage to the minimum. A small dose of morphine and atropine at the beginning of anæsthesia, which is continued through nasal tubes, diminishes the amount of anæsthetic needed and decreases annoying mucous tracheal secretions, while contributing to anæsthesia and seeming to reduce the effect of afferent impulse to the brain. The Ferguson incision—through the mid line of lip, about ala of nose, towards inner canthus of eye and thence out below the orbital margin—gives excellent exposure and command. This incision is a good one for epulis or other benign growths situated far back on the jaw, and with the bony support of the cheek unimpaired; the scar, with careful suturing, is scarcely distinguishable and the functions of the facial muscles are unimpaired. The flap is easily replaced and if the edges are kept clean very rapid primary union takes place. Cutting through bony attachments, the orbital plate should be left if possible to support the eye. The incision through the hard palate and the division from the soft should not be forgotten before avulsion of the bone. It is essential to avoid contamination of skin edges with tumor tissue and to work always outside the limits of the growth and not through

it in removal. The resulting cavity is packed snugly with borated or (better) iodoform gauze in one strip and the end is brought out of the corner of the mouth and secured after suturing the flap. The first packing remains six to seven days. Gauze wrung out of one of the milder antiseptic solutions replaces it at short intervals thereafter. The healing of the cavity is more rapid than would be expected, although with extensive areas several months may elapse before the mouth epithelium has covered the denuded surface.

One of the principal reasons for bringing this subject before you is to accentuate the fact that with good preparation and technic the operative mortality is not large. In recent years, in the hands of all operators, 12 to 13 per cent. European clinics have given 20 to 30 per cent. mortality, largely because the operations have been more extensive than in this country. I believe it is possible to employ Continental thoroughness and still obtain the best American figure heretofore recorded of about 9 per cent. and to considerably better it. The earlier fatalities were largely the result of sepsis and hemorrhage, pneumonia also contributing a large percentage (in one record 72 per cent.) of the deaths. Shock and exhaustion were frequently recorded, probably largely due to hemorrhage. We have controlled sepsis and hemorrhage almost completely, and pneumonia should be no more frequent than after the average operation. Not a few even advanced cases are cured by a thorough operation, if periods of five to nine years can be accepted as proof of cure; and in this domain I think they can, as recurrences when they occur are not long delayed. A very few have returned as late as three years plus several months.

In carcinoma of the upper jaw the neck should be dissected whether glands are palpable or not. In sarcoma, unless glands are palpable, dissection will rarely be necessary although it is a commendable precaution. The neck dissection may be done at a date prior to the removal of the jaw, or at the same time—depending upon the condition of the patient. It should in either case precede the removal of the jaw. In tumors of both upper and lower jaw, palpate the kidney region for possible hypernephroma. I hope to show by the cases presented that the operation is not necessarily even disfiguring, and in some is scarcely detectable in ordinary contact and without prosthetic apparatus. The best two examples could not be present in time for this meeting.

The skin of the cheek, even with well marked bulging from a growth within, seems rarely involved and can be utilized in replacement.

Cases that have been tampered with by local cauterization, electricity and incomplete excision have proved the most malignant. With the antrum, suppurative conditions may mask a coexistent or causative malignancy. A number of these growths appear to start in a nasal or antral polyp, and not infrequently a portion removed for diagnosis does not go deep enough to show the major condition. It is especially suggested to the laryngologist who treats the nose as well, the general practitioner and the dentist to be on the lookout for malignancy in certain recurring polypoid conditions of the nares

and about the antral orifice and in persistently ulcerated conditions of the mucosa about the teeth.

In a gentleman sent me recently with a diagnosis of extensive polyp formation of the left nares (the pathologist having reported pure polyp) my own specimen taken at a deeper portion showed squamous-celled carcinoma. At operation the entire antrum was shown to be filled with neoplasm and the disease extended up to the ethmoid cells.

Finally, the operation of to-day is not productive of considerable shock, bloodletting or delayed convalescence. Present methods of more comprehensive primary operation offer renewed hope and encouragement in this field of surgery, which has shown some brilliant successes in the past and I am confident will show an increasing number in the future.

OPERATIVE TREATMENT OF HARELIP AND CLEFT PALATE

By James H. Nicoll, M.B.

of Glasgow

consulting surgeon, glasgow hospital for ear, nose and throat; consulting surgeon, royal hospital for sick children

Within the limits of a single article it is impossible to discuss fully the treatment of these common and distressing deformities. In their cure or alleviation the best results are often attained only by the coöperation of the surgeon and the dentist, and the more severe cases tax the skill of both. In 1912 the British Dental Association did me the honor to invite me to give a demonstration of cases treated by operation, and in doing so I had occasion to comment on some alterations in the views recently held as to treatment. In the course of an operative experience of hundreds of cases, some of whom are now over twenty-five years of age, my own views have undergone considerable change. For what they may be worth these views on certain controversial points may be of service if only by way of stimulating discussion. The last word on some of these points has yet to be spoken.

Date of Operation.—The earlier the better, and this for three reasons: (1) The earlier the age the less the shock. Psychic or mental shock (the result of fear) is entirely absent in early infancy. Physical or corporeal shock (the result of pain) never attains considerable degree in the undeveloped nervous system of the infant. Stick a pin ever so lightly into an adult and he not only winces sharply but pulls away the injured part. Stick a pin into an infant of a few days old and he responds much less quickly and vigorously, and clearly does not locate the pain. His nervous system is not yet acute and educated. All he is apparently conscious of is a vague discomfort. (2) The earlier the age the more pliable and malleable are the tissues, and this malleability is particularly valuable to the operating surgeon in the partially ossified tissues of the maxillæ and premaxillary. (3) In cases of marked cleft palate it is often the case that a child born well-nourished steadily emaciates from starvation owing to the faulty deglutition. Operation for harelip and cleft palate should be undertaken within the first week or two of life. I have frequently operated on the second and third day. In "simple" harelip (soft tissues of lip only), where one operation may be all that is necessary, cure may be completed during the first week of life. In "alveolar" harelip and in harelip complicated by cleft palate, if the earlier of the successive operations necessary in such cases be undertaken during the first week and the others in as speedy succession as possible, cure may be completed within four to twelve weeks of birth.

Order of Steps.—In "alveolar" harelip and in harelip complicated by

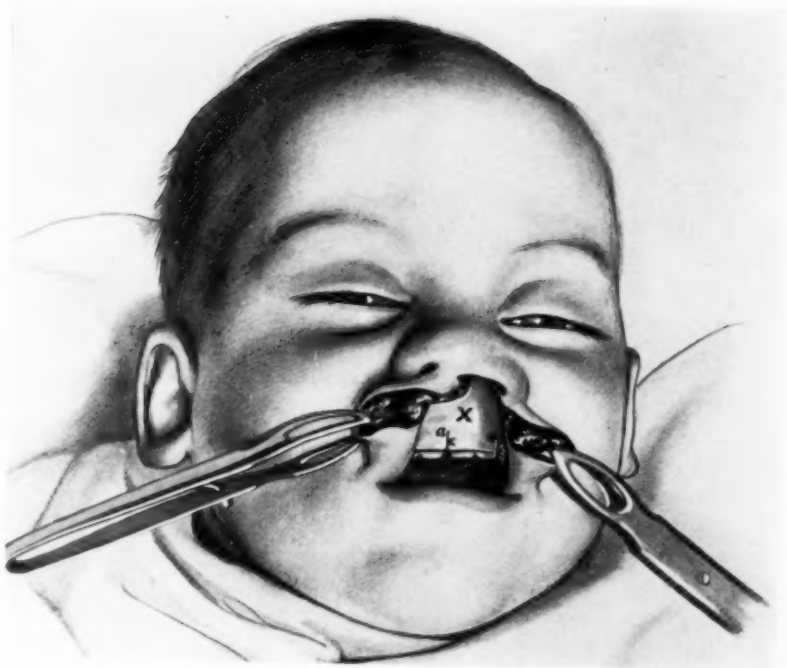

FIG. 1.—Tin-foil plating in harelip operations. The lip has been pared, and lip, ala and cheek freed; and the parts are ready for suture. A plate of tin-foil, x, moulded to the bone, has been fixed by two silkworm sutures, a, and á, which perforate tin plate and alveolar process. (R. B. The coronaries are temporarily controlled by the artery forceps. Pressure forceps and ligatures are seldom necessary in harelip operations.)

FIG. 2.—Tin-foil plating in harelip operations. Operation completed. The dotted line indicates the position of the plate (which is left for four to eight weeks), and bounds an area larger than the mucous-membrane-lined recess left after removal of the plate. A certain amount of reduction by contraction necessarily occurs.

Fig. 3.

FIG. 4.—Nostril moulding in harelip operations. Nasal splint fixed in position by silkworm suture passed through septum and tied in other nostril (knot shown). In this case a round splint has been used (to match the normal nostril). More often an oval splint is employed fixed with its long diameter antero-posterior. The splint is worn for one to six months. It is seldom earlier than two months after the harelip operation.

cleft palate all operations in the way of paring, moulding and wiring the malleable osseous structures should be carried to completion of union before the soft tissues are treated. That should be an unvarying rule even when, as is frequently the case, complete union of the alveolar arch and the hard palate can only be secured by several successive operations. In combined harelip and cleft palate the soft tissues concerned include lip and soft palate. The order in which these should be tackled offers a choice to the surgeon. Operators of limited experience may do well to close the soft palate first, thus taking advantage of the extra room for manipulation and the better illumination afforded by the gaping lip. But those accustomed to operate for cleft palate know that an intact lip (cases of cleft soft palate unaccompanied by harelip are quite common) offers no serious obstacle in operating on the soft palate. To such there is an inducement, after the hard palate has been closed and provided the soft palate has not been dealt with at the same time, to leave the soft palate to the last. That inducement is the increase of blood supply in the velum which follows closure of the hard palate and the lip. One of the chief causes of failure of union in cleft palate operations is the lack of blood supply in the pared and sutured margins, and that lack is more marked in the soft than in the hard palate. The soft tissues covering the hard palate resemble a carpet on a floor; those forming the soft palate resemble a ship's sail, unsupported by any vascular and steadying backing. Closure of the hard palate steadies the soft and increases its blood supply; and, except in these cases in which both hard and soft palates have been closed at one operation, closure of the soft palate may advantageously be made the last of the operative procedures.

Osteoplastic Operations and Flap Operations.—In "alveolar" harelip, especially in those cases in which the premaxillary occupies a projecting, and often also a tilted position, an osteoplastic operation necessarily forms the initial step towards cure. In many cases the soft tissues of the lip cannot be united at all until the intermaxillary has been pared, bent and wired into alignment with the maxillary alveolar arch and its firm union secured there. Further, every experienced operator knows that even in cases where the soft lip can be united over an alveolar gap the result will present a flat nostril or other unsightly features unless the alveolar gap is first remedied by an osteoplastic operation. On these points there is practical unanimity of opinion. Operation on the soft tissues of an alveolar harelip must be preceded by operation on the osseous structures.

It is on the question of the best technic in cases of cleft palate that opinion is divided. One school favors the flap method, the other the osteoplastic. The sliding flaps of Langenbeck and the turnover flaps of Davis Colley and Arbuthnot Lane often give excellent results. But in the hands of less experienced and skilful operators failure is not infrequent. Osteoplastic operation, as finally perfected by Brophy, is an alternative or auxiliary measure which in my experience has proved of the

highest value. It is difficult to understand the disfavor with which it has been regarded. Much of the unfavorable criticism of it seems to arise from misunderstanding. When one reads of "cutting through" the attachments of the maxillæ, and of "fracturing" the maxillæ in order to approximate them, and of "dissecting up" the cheek from the buccal surface in order to place the wires, one cannot wonder at the dangerous reputation of the operation. No such steps are ever necessary in Brophy's operation if undertaken when he advocates it, namely, during the early weeks of infancy. At that date the soft, partially ossified maxillæ can be pushed and bent towards the middle line and fixed there by wires without danger to the patient. In two papers read to the British Medical Association (*Brit. Med. Jour.*, Sept. 18, 1909, and Sept. 27, 1913), on the "Surgery of Infancy and Childhood," dealing with some 20,000 operations in *out-patient* children, I indicated that some hundreds of these were cases of harelip and cleft palate. A number of these were operations including bending and wiring of the maxillæ and intermaxillary by Brophy's and other methods. Osteoplastic operations on the maxillæ of *infants of a few days or weeks old* are *bending* or *moulding* operations, with little hemorrhage or shock; and many of my cases in the Children's Hospital and the Western Infirmary of Glasgow and in private practice have been operated on and treated throughout as out-patients.

Another criticism of such operations as Brophy's is that the altered position of the maxillary arches produces nasal obstruction and also imperfect alignment of the upper and lower teeth. Nasal obstruction must be rare. I have not met with a case. Imperfect alignment of the teeth, in such cases as it does occur, and these are for the most part those in which extensive alterations in the position of the premaxillary have had to be made, should not be treated by extraction of the irregular teeth, but handed over to the dentist for correction by regulating appliances. Irregularity and lack of alignment concern the incisors and less often the canines. In the molars they are seldom seen. Making use of both flap and osteoplastic methods in combination gives, I believe, the best results in cases of complete cleft palate in association with alveolar harelip, and the surgeon who proposes to deal with such cases should be familiar with the technic of both methods.

Coöperation of Surgeon and Dentist.—In cases of alveolar harelip the patient after operation should be placed under the observation of the dentist. Too often, when the date arrives, faultily erupting teeth, milk or permanent, are ruthlessly extracted. Such extraction not only sacrifices the tooth or teeth, but leads to atrophy and non-development of the portion of the alveolus bearing the empty tooth sockets.

NON-PARASITIC CYSTS OF THE SPLEEN*

By Adrian V. S. Lambert, M.D.

of New York

Surgeon to the Presbyterian Hospital

From time to time there appear in literature reports of cases in which the spleen has been removed on account of cystic disease. The histological examination of many of these cysts definitely establishes that they are not parasitic in origin and also that they are not the result of error in development, as, for example, dermoid cysts. Only two cases of the latter have ever been reported, that by Andral in 1829 ("Précis de Pathologie," 1829) and that by Kumaris in 1915 (*Archiv f. klin. Chir.*, cvi, 1915). The other non-parasitic cysts are unusual. The number of reported cases, however, is slowly increasing.

Monnier, writing in 1903, could find thirteen cases reported to which he added one removed at operation by Kronlein in Zurich (*Beiträge z. klin. Chir.*, lxi, 1903). Powers collected thirty-two cases and added one of his own (Annals of Surgery, xliii, 1906).

Heinricius collected in 1904 thirty-six cases of cysts of the spleen, seven found at autopsy, nine treated by puncture, two by marsupialization, two by incision and drainage, three by resection of the spleen, and thirteen, including his own case, by splenectomy (*Archiv f. klin. Chir.*, lxxii, 1904). In 1913 Fowler collected eighty-three cases from all sources (Annals of Surgery, lvii, 1913).

The term non-parasitic cysts includes a number of widely different conditions which may be separated into distinct groups. The following classification has been suggested by Fowler:

(1) Traumatic cysts (hæmatoma). These are large unilocular cysts.

(2) Infoliation cysts (traumatic of inflammatory inclusions of peritoneum). These are small multiple cysts which may be superficial or deep.

(3) Dilatation cysts (ectosis of splenic sinuses).

(4) Disintegration cysts (arising from arterial degeneration and occlusion or other arterial occlusion as from emboli, and resulting in infarction and necrosis of parenchyma).

(5) Neoplastic cysts (hæmangioma and lymphangioma).

(6) Degeneration cysts (arising from secondary changes in 5).

The following case substantiates the fact that there is no group of symptoms which can be recognized as characteristic of splenic cysts. The cases present a varied picture referable to neighboring organs and directly due to the great enlargement. It is presented because it brings up the interesting question of the pathogenesis of cysts lined by connective-tissue cells occurring

* Read before the New York Surgical Society, November 13, 1918.

in various parts of the body, as in bones, thyroid gland, omentum, mesentery and elsewhere. The case was referred by Dr. Graef in July, 1918.

C. G., age thirty-four, woman, was admitted to the Presbyterian Hospital July 8, 1918.

Chief Complaint.—Pain in epigastrium, loss of weight and strength.

Family History.—Father died at seventy-three of cancer of the stomach. Mother died at fifty-five from cancer of the mammary gland. One sister died of tuberculosis of the intestines. One sister died of some disease of the breast. Brother was killed in an accident.

Previous History.—She had the diseases of childhood—measles, whooping-cough, chicken-pox. In 1896 when she was twelve years old she had a severe attack of malaria. In 1906, twelve years ago, she was severely injured in an automobile accident. The left side of the body was badly bruised, and she was confined to her bed for three weeks. In 1912 she had a left ovarian cyst and the vermiform appendix removed; following which she was perfectly well until her present illness.

Present Illness.—In May, 1915, she began to have dull pain in the epigastrium while walking. This came on only at odd times. It was not constant at first, nor did it at this time have any relation to the ingestion of food. She had no nausea or vomiting. The pains gradually grew worse and more frequent, and in July, 1915, she began to lose weight, and by January she had lost thirty-six pounds. She also became nauseated during these attacks, but she never vomited. By January the attacks of pain and nausea would always come on shortly after eating, last fifteen or twenty minutes and then cease. They were not relieved by soda, milk, or water, and no particular variety of food seemed to aggravate them. In July, 1916, she began the systematic use of soda, but without relief. In October, 1917, she was placed on a strict Lenhartz gastric-ulcer treatment and spent most of the time in bed until January, 1918. Under this treatment she improved greatly and at the end of this period all her symptoms had disappeared and she had regained her weight and a great deal of strength. She soon returned to the regular routine of her daily life and commenced to eat a simple general diet. After a very short time her old distress and pain returned and became even more severe than before the Lenhartz treatment. She went to Atlantic City for rest and was much improved after two months. Shortly after her return in March, 1918, her distress again recurred and she now had attacks of pain which would last continuously for two or three days, which gradually wore away after abstaining from almost all food. During these periods she had a great deal of gas which she brought up. She had begun to lose weight again and she felt extremely weak.

Physical Examination.—Patient was fairly well nourished, rather pale, anæmic-looking woman who did not appear to be in any great pain. Heart and lungs normal. No glandular swellings felt anywhere. The abdomen was soft, no rigidity and no masses felt. Liver percussed from fourth rib to free border and was not felt. A median scar above symphysis was not tender. There was a tenderness on deep

FIG. 1.—X-ray of stomach after ingestion of barium. Note irregularity of outline characteristic of an extra gastric body pressing against and thus infolding stomach wall.

FIG. 2.—Internal surface of spleen showing large area denuded of peritoneum the site of former adhesion to stomach and diaphragm.

FIG. 3.—Showing the external surface of spleen. Note the two protrusions of the cystic cavity.

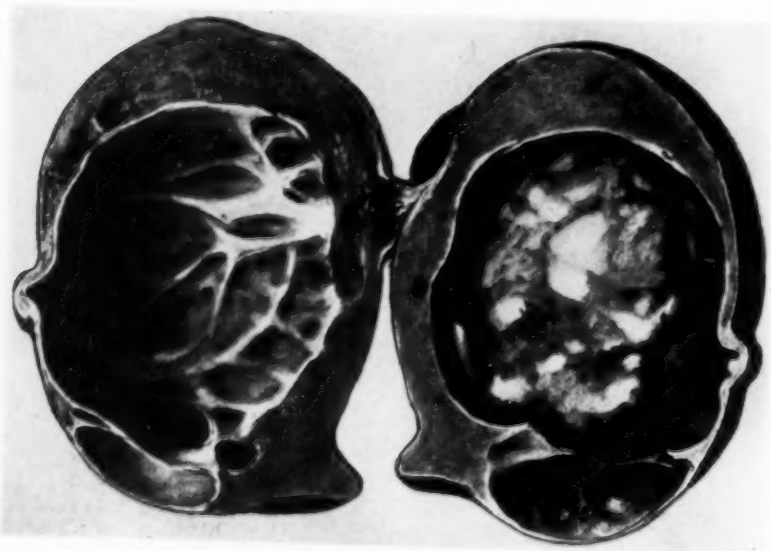

FIG. 4.—Spleen sectioned showing the granular character of cyst contents and the relationship of cyst to capsule of spleen. Note also cavity with the thin membrane-like septa separating the loculi and the ridges on the surface.

FIG. 5.—Low power showing loculi of the cyst and also the free edge of the projecting folds, separating them.

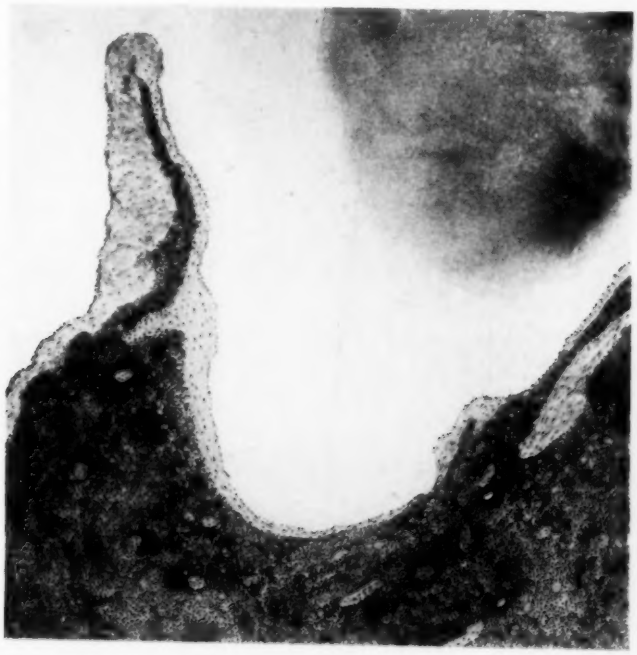

FIG. 6.—Shows the septa projecting in cyst cavity. Note splenic pulp persisting in the septum.

FIG. 7.—Spleen sectioned showing the granular character of cyst contents and the relationship of cyst to capsule of spleen. Note also the multilocular character of cyst cavity with the thin membrane-like septa separating the loculi and the ridges on the surface.

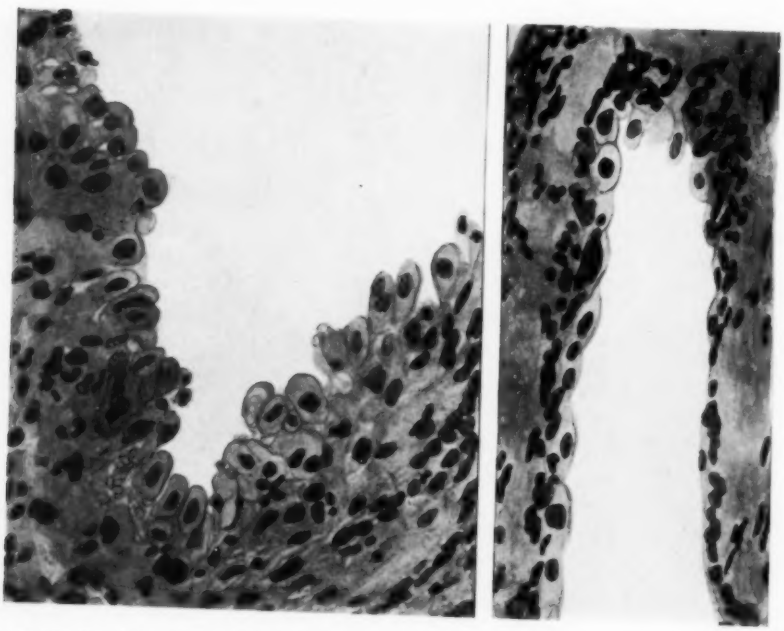

FIG. 8.—Shows the character of the cells lining the cyst. Note the great variety in form and irregular arrangement.

pressure over the left side below free border of the ribs. Spleen not felt.

Gastric analysis showed slight trace of occult blood with Benzedine test. Free HCl 36. Total, 50. Blood examination showed moderate increase in leucocytes. Red blood cells, 3,800,000; hæmoglobin, 78 per cent. Repeated examinations of the stools for blood were negative.

X-ray examination showed the characteristic picture of a change in outline of the stomach dependent on pressure from without—what Carman has described as pseudo-hour-glass stomach (Fig. 1). The pylorus showed no change in outline which could be considered pathological. No fluoroscopic examination was made.

Operation, July 10, 1918.—Splenectomy. A 5-inch median incision above the umbilicus to left of falciform ligament.

The spleen was enlarged greatly in thickness but only slightly in length. It was fixed and firmly adherent to the diaphragm. The pedicle was long and readily ligated. The adhesions were separated with moderate bleeding and the pedicle ligated *en masse* and then divided, the individual vessels being ligated separately. Wound closed without drainage. There were no untoward effects and wound healed per primum.

Blood Examination July 11th, First Day after Operation.—Red blood cells 5,640,000, white blood cells 27,200, polymorphonuclears 80 per cent.

July 13, Third Day after Operation.—Red blood cells, 5,550,000; hæmoglobin, 100 per cent.

July 16, Sixth Day after Operation.—Red blood cells, 5,820,000; hæmoglobin, 90 per cent.

Pathological Report.—The specimen consists of a spleen which is greatly increased in size, chiefly in thickness. There are several areas where the peritoneal cover is wanting (Fig. 2). It measures 9x8x6 cm. On the convex surface there is a white area which is on the summit of the larger of two distinct prominences, which appear as distentions of the capsule at these points (Fig. 3). These prominent areas are elastic and fluctuate. They are evidently the site of cystic cavities. On section these two cavities communicate freely with one another and form one large single cavity, from which there lead out numerous smaller cavities. Its walls are smooth and shining and present numerous ridges on their surface (Fig. 4). These do not form trabeculæ passing as bands across the cavity. In many places the septa separating the different loculi of the cystic cavity are reduced to thin transparent folds, having a sharp, free, sickle-like edge, which projects free into the cavity of the cyst (Figs. 5 and 6). In many places there are thickened ridges in the folds. In one place the cyst lining is separated from the surrounding splenic tissue as a thin transparent membrane by what appears to be a recent hemorrhage.

The contents of the cyst was an amber-colored, clear fluid, too thick and glairy to be drawn through a fine hypodermic needle. On fixation, the cyst contents coagulated and had a granular appearance where it had shrunken from the cyst walls. On section it showed whitened areas surrounded by a brownish, grey, mouse-colored granular material (Fig. 7). The cyst wall may be readily stripped from the surrounding splenic pulp as a distinct membrane, and even where it lies directly beneath the capsule of the spleen and in intimate contact with this capsule it is distinct and can be readily separated.

Microscopic Examination.—The wall of the cyst is sharply differentiated from the surrounding splenic tissue. It consists of an envelope of fibrous tissue, which has few nuclei. In many places this capsule is thickened where ridges are found in the wall. Here we find blood-vessels in the wall. It would seem that during the increase in size the cyst had encroached on the surrounding splenic tissue, but the presence of blood-vessels and more resistant tissue here had prevented their disappearance. This fibrous-tissue envelope is covered by modified connective-tissue cells, which form the lining of the cyst. These cells are wanting in many places, having been stripped off with the contents, as this contracted owing to the action of the fixative fluid. Where they remain in situ, they appear as a layer of cells, ellipsoidal in form for the most part (Fig. 8). In many places where the layer is stripped off we see the cells on the flat, and here they have irregular forms, some crowded close together arranged in a mosaic, while in other places the cell bodies are widely separated, with intercellular ground substance appearing between them. The nuclei of these cells stain deeply and the cell bodies also take the stain well. In some places, particularly in a deep recess in the reëntrant angle between the wall proper and a trabecula, the cells have a more cuboidal form, and here there appear to be several layers of them. Sections through the hilum show the presence of an old infarct which is undergoing organization.

There are many explanations of the pathogenesis of these cysts, and from a study of the case reports and histological findings it is evident that we are dealing with a complex and not a simple problem. No single theory appears to explain satisfactorily all the cases. This is not surprising when we consider what varied pathological pictures the different cases present. The patients' age, and sex, and numerous diseased conditions have been invoked as contributory causes. Pregnancy and malaria are the most constantly mentioned factors. No closer or more direct connection can be established than to state the fact that among the cases reported there are more women than men, that many of the patients have had malaria and in a number the first symptom appeared during pregnancy.

On the other hand, traumatism in many instances immediately preceded the occurrence of symptoms and the contents of the cysts in many cases showed evidence of an antecedent hemorrhage (Camus, "Thèse de Paris," 1905). In this discussion I have ignored the examples which are the result of degeneration of neoplasms and also the cases which are represented by lymphangiomata.

Fink[1], Ashoff[2], and others, consider the latter as the pre-existing conditions in most cases. Undoubtedly this is true of multiple cysts. Other explanations offered are that of Schmidt[3] and Ramdohr[4], who believe that cysts develop from changes in portions of splenic pulp which have prolapsed through rents in the capsule, occurring as a result of splenic enlargement

[1] Prager, Med. Zeitschr. f. Heilkund., vi, 1885.
[2] Lubarsch und Ostertag Ergebnisse d. Allg. Path., vii, 1900–1.
[3] Virchow's Archiv, clxiv, 1901.
[4] Virchow's Archiv, clxiv, 1901.

from malaria, typhoid or pregnancy. Renggli[5] considers them due to a snaring off of peritoneal cells, which thus gives rise to inclusion of cysts.

Pilliet[6] believed they arose from transformations in angiomata. One can readily distinguish in such tumors many cysts which form from hemorrhages occurring in these growths. None of these etiological factors appears to have been the starting point of our present case.

Bötcher[7] reports a case in which he believes the cyst arose from necrosis of an area of the spleen which resulted from the occlusion of the vessels due to amyloid degeneration. In this connection infarcts of the splenic vessels have been reported as having occurred in connection with these cysts, Bircher[8] having observed such a case.

In view of the pathological findings I believe that such a condition was responsible for cyst formation in this case, as the presence of old thrombosed vessels would rather confirm this view. The history of trauma twelve years previous must be considered and it is interesting to speculate on how and why a cyst should ever form following a hæmatoma. The study of the morphology of the cells lining such a cavity throws no light on this problem. For these cells do not differ from those covering other connective tissue-lined cavities, such as adventitious bursæ or spaces surrounding non-irritating foreign bodies. They are simply modified connective tissue cells—that is, cells of mesochymal origin; and when they line cavities containing collections of fluid of long standing, they take on the cuboidal form. It does not appear to matter whether the mesochymal cells have served as lining to blood or lymphatic vessels, or become the essential covering of the peritoneum; they revert to this type, and are indistinguishable morphologically from those which have never been in their life history differentiated from simple connective tissue.

It seems necessary to invoke some biological factor to explain the continued presence of free fluid within the body. It does not appear probable that the fluid is a true secretion. This would ascribe to these cells a power which we are accustomed to associate with those of a more specialized type. It would seem more probable that it was a question of osmosis or transudation and that there exists a difference in surface tension in the different portions of the bodies of the cells lining the cyst. It is not difficult to conceive that there might be a distinct contrast between the surface tension on the free face of the cell body turned toward the cyst cavity, where it lacks all support from surrounding structures, and that face opposed to the underlying fibrous capsule, bathed as it is by the body fluids exerting a certain degree of

[5] Inaug. Diss. Zurich, 1894.
[6] Bull. de Société de biologie, Paris, 1892.
[7] Dorpster. Med. Zeitschr, i, 1870.
[8] Deutsche Zeitschr. f. Chir., xcii, 1908.

pressure against it. The slow progressive increase in fluid contents could then be due to that difference in surface tension. There has never been, so far as I can discover, any exhaustive study of the chemical composition of the cyst fluid. Such an investigation might aid us in solving this problem.

At present no satisfactory explanation has been offered to account for these cysts, and the subject offers a profitable field for research.

The symptomatology is largely based on pressure and the increased size of the spleen. Either the condition is recognized on account of the mass of the greatly enlarged spleen, or because of the spleen having displaced other abdominal organs. It is frequent to have gastric disturbances. Vomiting is often present. The majority of cases complain of pain, for the relief of which the patients first consult a physician. There are no symptoms which point to disturbance in the splenic function.

The majority of cases are not associated with dense vascular adhesions and splenectomy has become the treatment of choice by most surgeons.

VARIABILITY OF THE PATHOLOGY AND SYMPTOMS OF CHRONIC INTESTINAL OBSTRUCTION*

By Moses Behrend, M.D.
of Philadelphia
surgeon to the jewish and to the mt. sinai hospitals

It is not always easy to decide what constitutes chronic intestinal obstruction, but any case that extends over a prolonged period without grave symptoms and not necessitating an immediate operation may be classed in the category of cases of chronic intestinal obstruction. This period of time may be indefinite, extending over weeks, months and even years. The cases of long standing simulate those of the pronounced neurasthenic, but by abdominal section the true pathology is revealed. The character of the symptoms varies with the location and intensity of the pathology. Often extensive pathological conditions give rise to few symptoms.

Pain is the most common symptom, while vomiting, always found in acute intestinal obstruction, is practically absent. Diagnosis is easy when a mass can be felt, but, when one must depend on the subjective symptoms entirely, one is often surprised at the pathology encountered at operation. Some of the various conditions encountered in the author's experience have been a subhepatic collection with duodenal adhesions, an enterolith with adhesions to the ileum and appendix, slowly forming volvulus, purpura hæmorrhagica intestinalis. The operations performed in these cases will be described. There was no mortality in this series.

Case I.—*Subhepatic collection with gastric, duodenal and colonic adhesions.* The patient was a woman thirty-five years old. She had been sick six weeks before I was called in consultation by Dr. William E. Raken. Upon examination a large mass was felt in the right hypochondriac region. This mass was continuous with the liver with dulness above extending about four inches below the costal border. At operation a large amount of fluid was obtained in the subhepatic region. The exact source of this fluid was never fully determined. The fluid might have been derived from a ruptured duodenal ulcer, a perforated gall-bladder or an hematogenous infection. Adhesions were noted involving the stomach, duodenum and hepatic flexure. Operation never fully relieved the patient of her symptoms, which were due to the adhesions of the viscera to the abdominal wall and to each other. The sole subjective symptom of obstruction was continuous pain, nausea, but no vomiting.. The pulse was gradually increasing in rate. The symptoms of intestinal obstruction were present at the first operation but were not recognized on account of the large volume of fluid being considered the causal factor.

* Read before the Northern Medical Association, April 12, 1918.

The second operation was performed two weeks after the first. A new incision was made in the median line from the ensiform cartilage to the umbilicus. The transverse and descending colons were found collapsed; the ileum was distended. An anastomosis was made between the transverse colon and a portion of ileum. The original incision in the right hypochondriac region and the underlying adhesions were totally disregarded. This is an important point in many cases of intestinal obstruction, namely, to disregard the pathology altogether, not to disturb dense adhesions, but instead to make an anastomosis between healthy viscera.

CASE II.—*An enterolith with adhesions to the ileum and appendix.* Admitted to the Jewish Hospital September 27, 1917. This was a case of considerable interest. It occurred in a woman twenty-seven years old. She had the typical symptoms often found in cases of chronic intestinal obstruction due to an enterolith. She complained of general vague pains (hypochondriacal in character), constipation, nausea and especially pain in the epigastric and right iliac regions. There was no vomiting. She lost considerable weight, a fact which has been noted by others who have reported cases of this character. The only point of interest in the previous history is the fact that in January, 1917, she was operated upon at the Samaritan Hospital, when a dilatation and curettage and a perineorrhaphy were performed. After the operation it was thought that she would not recover on account of the tremendous distention of the abdomen. No doubt the conditions that we found at operation were present at this time, and may be considered the cause of the abdominal distress. Physical examination revealed an ill-nourished woman, anæmic and poorly developed. Palpation of the abdomen elicited tenderness in the right iliac fossa, but no mass could be felt.

The operation was performed under nitrous oxide gas and oxygen. The abdomen was opened through a right rectus incision. The serous lining of the terminal portion of the ileum was covered with numerous white tubercles strongly suggesting tuberculosis. The appendix was located and found considerably enlarged, teased out, adherent to the ileum and containing in common with the ileum the large enterolith shown in Fig. 4. A communication existed between the appendix and the two approximated loops of intestine, constituting by nature's process an entero-enterostomy and an appendico-enterostomy. Upon attempting to separate the adherent portions of the ileum from the appendix the former was torn in several places, necessitating a resection of twenty inches of ileum. The open ends of the ileum were closed and a lateral anastomosis was performed. The abdomen was closed with drainage. In this instance we are unable at this time to decide whether the enterolith had its origin in the appendix or the ileum.

Cases of enterolith of the gastro-intestinal tract have been reported by Alexander, F. P. Henry, Malcolm McLane, W. L. Moores, Marshall, Ward and others. According to Phillips, cases of enterolith are comparatively rare in the human being, but found quite often in

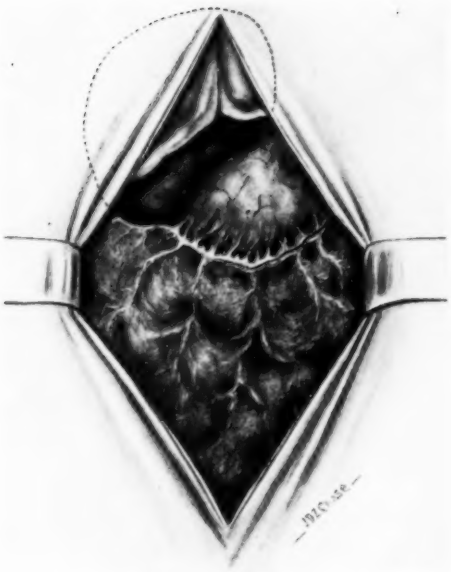

FIG. 1.—Case I, showing subhepatic collection.

FIG. 2.—Case I. Anastomosis of transverse colon to ileum on account of adhesions around duodenum as shown in *a*.

FIG. 3.—Case II, showing enterolith in ileum covered by frayed-out appendix.

FIG. 4.—Case II, showing enterolith with resected ileum. Appendix removed.

FIG. 5.—Case III, showing slowly forming volvulus.

FIG. 6.—Case III, showing anastomosis of sigmoid to descending colon. Volvulus not removed.

FIG. 7.—Case III, showing anastomosis as result of operation five months before.

the lower animals. Enteroliths usually occur in the cæcum, but when found in the ileum are seen most frequently in the lower part of the ileum.

CASE III.—*Slowly forming volvulus.* This case was of unusual interest on account of the manner in which the symptoms appeared in the presence of a serious pathological condition. The symptoms came on rather stealthily in a woman enjoying previous good health. About six weeks before I saw her, in consulation with Dr. I. Valentine Levi, she noticed that her bowel movements were not as free as usual, in fact constipation appeared with some pain in the abdomen. Her bowels moved but rather ineffectually. Physics and enemas were not very effectual. She did not vomit; there was no nausea. The patient looked comfortable, in fact she refused to go to the hospital because she did not feel sick enough. A diagnosis of intestinal obstruction was made on account of the unproductive bowel movements. She was operated on at the Jewish Hospital November 22, 1917. We found an invagination of the sigmoid with adhesions and several twists in the gut (Fig. 6). In this instance the mass was again disregarded; instead of removing it the distal portion of the sigmoid was brought up to the descending colon where a lateral anastomosis was performed. Fig. 7 illustrates the anastomosis performing its function perfectly five months after operation. After a rather stormy convalescence the patient made a fine recovery.

CASE IV.—*Purpura hæmorrhagica intestinalis.* Admitted to the Jewish Hospital April 8, 1917. The patient was a male, aged thirty-three years, complained of severe abdominal pain and constipation. He was seen, in consultation with Dr. S. Solis-Cohen, in the Medical Wards. Before admission to the hospital the patient was unable to have a bowel movement to which he attributed his symptoms. Since the onset of his constipation he complained of pain in the epigastric region which he described as dull aching in character. Pain was present constantly, but it never localized itself. Four days prior to admission he vomited four or five times a day and had vomited several times a day since admission. He soon developed pain in both knees followed by swelling, later the wrist joints became swollen and painful. A closer inspection of the abdomen elicited liver dulness extending from the sixth interspace to a point somewhat below the costal border. The abdomen was very tender, tenderness being greater in the right upper quadrant than in any other region. Posteriorly there was a petechial eruption hemorrhagic in character.

At operation the gall-bladder was found filled with dark, viscid bile. This was drained, the bile flowing with difficulty through the cannula. A cholecystostomy was performed. The appendix was removed through another incision. Here an excess of peritoneal fluid was noted, and in trying to determine the cause of the presence of so much fluid, it was found that the small intestine from the jejunum to the ileum, and including the ileum covering, in all about eight feet of gut, there were found telangiectatic tumors circumscribing the entire lumen of the intestine. The most advanced and the most obstructive character of

these growths were nearest the jejunum. As the ileum was reached the tumors became less firm and the hemorrhagic spots covered less of the circumference on the bowel. No resection of the intestine was performed because the lesions covered such a large area and on account of their progressive character it was impossible to tell where these hemorrhagic areas would stop.

A review of the previous histories illustrates the diversity of intra-abdominal conditions causing chronic intestinal obstruction.

Case I shows the proper procedure when extensive adhesions around the duodenum, colon and stomach are encountered, namely, to disregard the pathology and make your anastomosis in a healthy area through a separate incision. Case III also shows that wherever it is hazardous to remove the lesion it is better to ignore the cause and make the anastomosis around the seat of trouble. This is a preferable procedure in this region, when it can be done, on account of the comparatively poor blood supply of the sigmoid flexure in relation to the rest of the intestinal tract.

Case IV illustrates one of the rarest conditions causing symptoms of chronic intestinal obstruction. A diagnosis of cholecystitis was made on account of the greatest tenderness being in the right hypochondriac region. Gall-bladder disease was actually present on account of the black gummy bile which flowed with great difficulty through the cannula. Upon making a separate incision to remove the appendix an excess of intraperitoneal fluid was noted. This led to the discovery of the hemorrhagic masses extending from the jejunum and including the ileum.

Case II was the only one in which a resection of the intestine was necessary.

Finally, in all the cases pain was a constant symptom, not always, however, specific in character as to the location of the lesions. Vomiting, a constant symptom in acute intestinal obstruction, was present only to a considerable degree in Case IV. The other cases vomited rarely or not at all. The pulses of all the patients were not rapid. Another striking feature was the absence of toxæmia in these cases, so commonly found in acute cases. All the patients reported recovered and are still enjoying good health, whereas in acute intestinal obstruction the mortality is 50 to 60 per cent.

RESECTION OF THE CÆCUM AND ASCENDING COLON*

By J. Shelton Horsley, M.D.
of Richmond, Va.

The principles that underlie an operation are more interesting than the mechanical details of the technic. The influence of certain physiological and pathological laws in causing the abandonment of lateral intestinal anastomosis and the gradual adoption of the end-to-end method is particularly striking. When surgeons began to use the needle and thread for uniting intestine instead of mechanical appliances, lateral anastomosis was much in vogue. Fifteen years ago when this transition was occurring, probably the majority of all intestinal resections was followed by lateral anastomosis, particularly if the colon was involved. At present the opposite is true, and even in the large bowel the end-to-end or axial union is becoming popular. Two recent papers, one by Lockhart-Mummery (*Surg., Gyn. and Obstet.*, February, 1917, p. 247) and the other by Donald C. Balfour (*Trans. Southern Surg. Association*, vol. xxx, p. 343), have strongly advocated this method in colonic surgery.

Senn and Reichel called attention to the interference with peristalsis at the site of lateral anastomosis. Cannon and Murphy (Annals of Surgery, vol. xliii, p. 512), after röntgen ray examination of animals in which end-to-end and lateral intestinal union had been done, found that there was not the "slightest evidence of stasis of food in the region of operation" with an end-to-end method. On the other hand, peristalsis was apparently abolished in the region of a lateral anastomosis, the fecal contents being pushed through the anastomosis only when a column of it extended into the unaffected proximal (oral) loop of bowel where peristalsis was unimpaired.

The reasons for this are that the opening is not in the axis of the bowel, the severed circular fibres cannot act upon the bowel contents satisfactorily, and there are two blind pouches in which the fæces tend to collect. The proximal (oral) intestinal pouch is emptied with great difficulty. I have seen a dog die as a result of a small piece of bone lodging in this pouch and ulcerating through.

Lateral anastomosis is made in the direction of the long muscle of the bowel, and these external longitudinal fibres are split instead of being cut across as in the end-to-end method. Contraction of these fibres tends to close the opening in the bowel and a very long lateral anastomosis has to be made to prevent too much contraction.

There is more suturing to be done in lateral anastomosis. The two

* Read before the Southern Surgical Association, December 19, 1918.

ends of the bowel have to be closed, then two openings made into the bowel and the wounds sewed together.

As a final objection to lateral anastomosis, it requires much more bowel to make a lateral than an end-to-end union. In the small intestine this is of no great consequence, but in the colon it may be very serious, as shown by Lockhart-Mummery, and may result in resection of too small an amount.

The objection that has been urged to the end-to-end method has been the fact that it would leak at the mesenteric border. As pointed out in previous communications, in which a new method of intestinal union was described (ANNALS OF SURGERY, vol. xxxviii, p. 747; *Trans. Southern Surg. Association,* vol. xxi, p. 198; *Southern Medical Journal,* vol. viii, p. 298; "Surgery of Blood-Vessels," J. Shelton Horsley, M.D., pub. C. V. Mosby Co., 1915, p. 204), the triangular space where the mesentery splits to envelop the bowel has been considered a bad place. This is because the operator by cutting into this space with the same scissors or knife that divides the mucosa of the intestine infects this triangular space, which is rich in lymphatics and blood-vessels, and the infection causes the sutures to give way. It can be avoided by dividing, clamping, and tying this space and by clamping and tying the mesentery before opening the bowel (Fig. 1).

The question of infection in an intestinal wound and the nutrition of the wound are closely allied. If the infection is slight and the nutrition good, the infection may be overcome. It is important to do away with infection as much as possible, and it is also important to have a good blood supply, but to cut the bowel too obliquely to obtain this blood supply may interfere with peristalsis. Disinfecting the intestinal ends before suturing should always be done, particularly in suturing the colon. It may be impossible to sterilize the mucosa just as it is impossible to sterilize the skin by any known method which does not destroy the skin, but certainly the majority of the bacteria can be removed and then the needle and thread will not carry the infection they would if the fecal matter was simply squeezed out and no further effort made to clean the bowel end. Those cases of leakage opposite the mesenteric border in end-to-end union of the colon that some operators have noticed may be due to lack of cleaning the bowel ends with antiseptic solution and so preventing a mild infection where nutrition is weakest.

Kellogg (*Surg., Gyn. and Obstet.,* vol. xvii, p. 563) has pointed out the advisability of reproducing a valve like the ileocæcal valve when the small intestine is united to the large. It has been the common experience that when a union is made without a provision of this kind the small bowel dilates or thickens. This is probably due partly to infection from the colon and partly to the back pressure of the gas in the large intestine. While, of course, such a valve cannot prevent the entrance of a small amount of bacterial flora from the colon, it may act as an ileocæcal valve and protect the small bowel from an overwhelming amount of colonic fecal matter

FIG. 1.—Before the bowel is divided its mesentery is cut close to the bowel wall and the triangular space caused by separation of the layers of the mesentery just before they cover the bowel, is clamped with a hæmostat and ligated with silk or linen. This area is composed of areolar tissue rich in blood-vessels and lymphatics which absorb quickly, and, even though it is closed after it has been inoculated, the germs are merely sealed in and are likely to cause breaking down of the union at this point later on. The procedure indicated here obviates this and also brings together the peritoneum at this point.

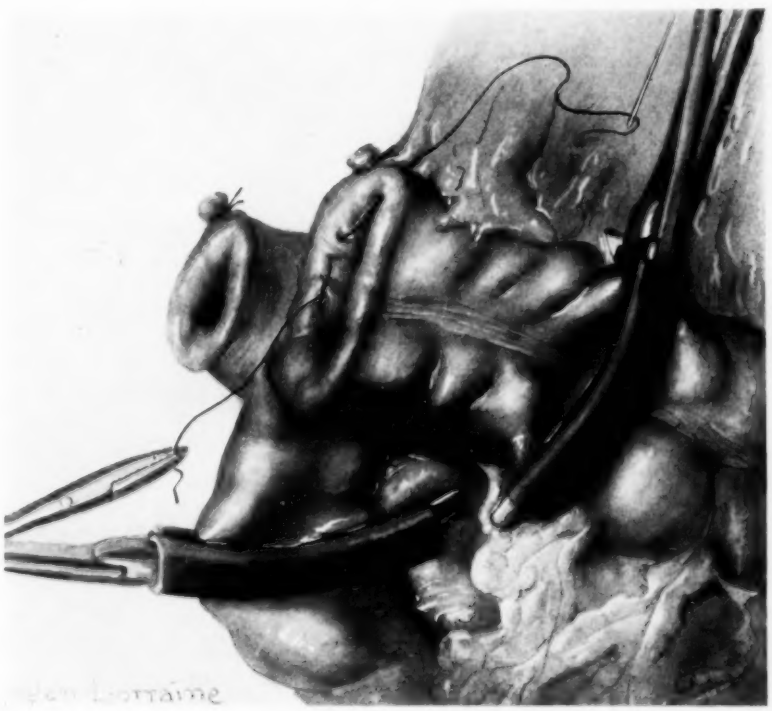

FIG. 2.—The bowel ends have been cleaned with sponges dipped in antiseptic solution and the suturing has begun. A straight needle and linen thread is used, and, starting on the mucosa of the colon, the needle is carried through the colon to the ileum, pierces the ileum about an inch from its end, and returns in a reverse direction. The thread is tied, making a mattress stitch, and the short end of the thread is clamped with a hæmostat. The suture is continued as a continuous mattress stitch.

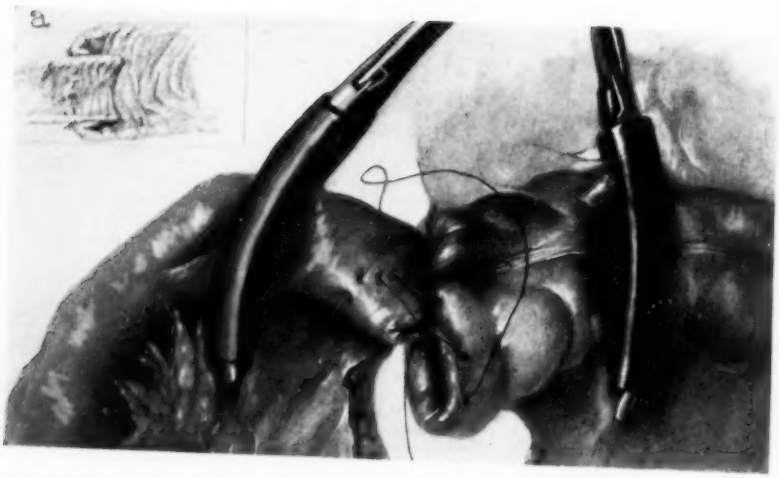

FIG. 3.—After the mesenteric border has been passed, the needle is brought on to the surface by thrusting it through the colon and suturing is continued as a right-angle stitch, penetrating all coats of the intestine, uniting the edge of the colon to the ileum about an inch from its end, and taking more of the colon than the ileum in each bite. About every third stitch a back stitch is taken to prevent the stitches from being drawn too tight. It is finished by tying to the original short end that was left clamped. *a* shows section of the bowel after completion of the operation and insertion of interrupted catgut mattress stitches.

FIG. 4.—In an enterostomy the incision is made through the peritoneal and muscular coats down to the submucosa. At one end of the incision a purse-string sutrue is inserted.

FIG. 5.—The mucosa within the grasp of the purse-string suture is punctured and a catheter is quickly inserted, the purse-string suture being tied snugly about the catheter. One end of the purse-string suture is threaded in a sharp needle and fixes the catheter in position. The portion of the catheter that lies on the incision is buried by a right-angle stitch.

FIG. 6.—The enterostomy has been completed. Usually there is no leaking of the fecal matter when the catheter is withdrawn, due to the valve formation of the mucosa (Coffey).

which would otherwise flood the small bowel with each retrograde peristaltic wave.

The operation here described was developed as a result of experimental and clinical experience and is based upon the principles that have just been discussed. The steps of the operation are:

1. A thorough mobilization of the cæcum, ascending colon, and the lower part of the ileum by dividing the peritoneum to the outer side of the mesentery of the cæcum and ascending colon.

2. Division of the mesentery which supplies the segment of bowel to be removed, taking care to keep as close to the bowel as the indication for the operation permits. The triangular surface at the mesenteric border of the bowel is clamped and tied and all of the mesenteric vessels are clamped and tied (Fig. 1).

3. The bowel which is to be resected is packed off by gauze wrung out of hot saline solution. Wet gauze should be carried under the loop as well as around the ends where the section is to be made. Then the diseased segment is clamped as close as possible to the point where it is to be cut, and intestinal clamps are placed at a sufficient distance from this point on the healthy bowel so as not to interfere with suturing.

4. The bowel is divided with scissors, cutting somewhat obliquely to obtain better nutrition and from the mesenteric border outward.

5. The edges of the mucosa of the healthy end of the bowel are caught at three or four places with small forceps and the end of the bowel from the clamp to the cut surface is thoroughly cleaned with gauze sponges dipped in bichloride solution. After being cleaned of all fecal matter, the excess of bichloride is mopped out and the end of the bowel is covered with a gauze pad wet in saline solution. Then the other end of the diseased loop of bowel is cut off and a similar procedure is gone through with.

6. Suturing is begun, using a straight needle and linen thread, and beginning on the mucosa of the colon. The needle is carried through the colon to the ileum and pierces the ileum about an inch from its end. The needle pierces the ileum from without inward and returns in a reverse direction through the ileum and colon. The thread is tied on the mucosa of the colon, making a mattress stitch. The short end of the thread is clamped with a hæmostat (Fig. 2).

7. The suture is continued by carrying it back and forth after the manner of a continuous mattress stitch, taking more of the colon than of the ileum in each bite of the stitch and keeping an inch behind the end of the ileum.

8. After the mesenteric border has been passed, the stitch is brought on to the surface by thrusting the needle through the colon and is then continued as a right-angle stitch, penetrating all coats of the intestine, uniting the edge of the colon to the ileum an inch from its end, and taking more of the colon than the ileum in each bite. About every third stitch a back stitch is taken to prevent drawing the suture too tight. When the

suturing has reached the point where it began, it is carried on the ileum one stitch beyond the short end of the thread, which was left clamped, and is then tied to the short end. The knot is tied in the line of the incision so it will sink well into the bowel. It is tied three times and cut short (Fig. 3).

9. A row of interrupted mattress stitches of fine tanned catgut is placed around the whole line of sutures. This is done to promote the valve formation and to add to the safety at the point of union. The mesentery is sutured together loosely, and a piece of omentum, if it is in the neighborhood, is fastened over the line of union.

In resection of the colon the same technic can be used, omitting, of course, the valve construction feature.

Only an inch of ileum is projected into the colon because if there were more the eversion of the mucosa of the ileum would probably not be sufficient to cover the peritoneal surface of the ileum which lies within the colon, and

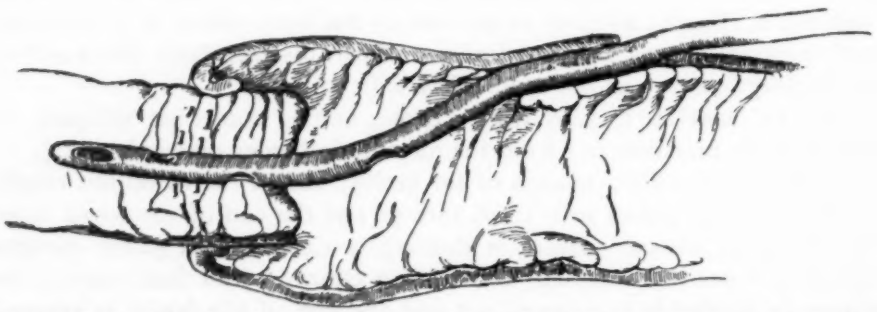

FIG. 7.—Section shows the union of the ileum and colon complete with the enterostomy tube in position. Note the oblique manner in which the tube is introduced.

this execssive amount of peritoneal surface would be subjected to the irritating effect of the contents of the colon and contraction might result.

After operations on the colon, gas is often annoying. A. J. Oschner has written fully of this complication (*Journal A. M. A.*, vol. lxvii, p. 483). On the left side it may be avoided by passing a tube from the anus through the intestinal union at the time of operation. On the right side, however, the tube would be too long and might exert injurious pressure at the flexures. I believe an enterostomy with a soft rubber catheter would be advisable. I have not yet done this in resection of the cæcum and colon, but it could be easily performed and should add but little danger to the resection. The method of enterostomy I have used frequently in intestinal obstruction is based on the principle of Coffey of forming a valve of the mucosa and is shown by the illustrations. An incision about two inches long is made with a sharp knife down to the mucosa. A purse-string suture is placed at one end and the mucosa within the grasp of this suture is punctured (Fig. 4). A soft rubber catheter is quickly inserted through the puncture, the purse-string suture tied snugly, and an end of

FIG. 8.—Hypertrophic tuberculosis of the cæcum. Drawing of a transverse section of specimen removed from Mrs. D.

FIG. 9.—Drawing of the exterior of specimen removed from Mrs. D. Note the portions of the ileum that are covered with tubercles and the marked contraction of the ileum at one point. There was no evidence of any other tuberculosis in the abdominal cavity. After resecting that part of the intestine including the cæcum and ascending colon, a separate resection was made of the segment of diseased ileum.

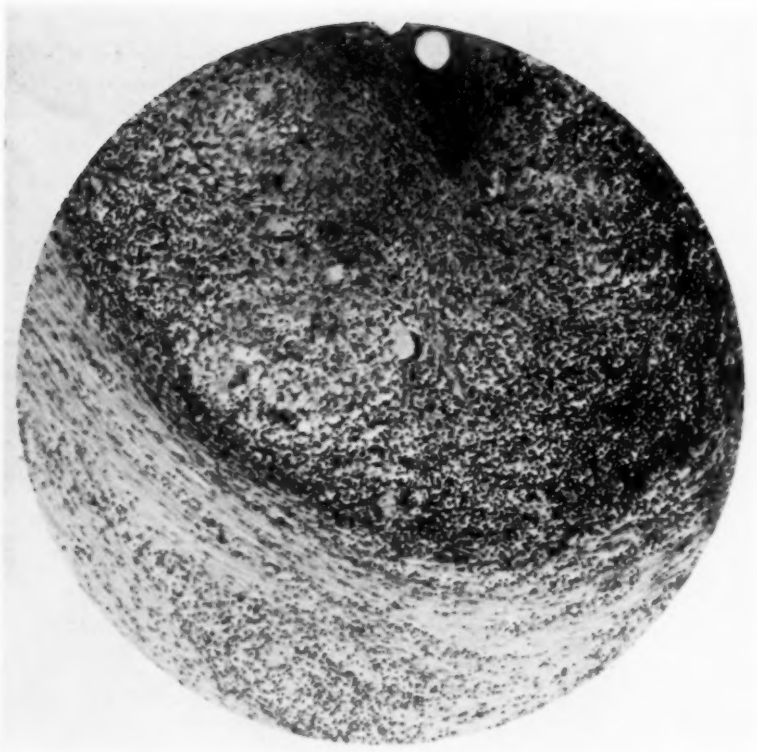

FIG. 10.—Photomicrograph (x85) of section of one of nodules of the specimen shown in FIG. 9, showing giant cells and other typical histologic structure of a tubercle.

the suture is threaded in a needle and transfixes and holds the catheter in place. The portion of the catheter over the incision is then buried with a right-angled suture (Figs. 5 and 6). The catheter will stay in position at least five or six days and when removed there is little or no leakage of fecal contents. In connection with resection of the cæcum and colon a catheter with several perforations could be introduced through a stab wound in the abdominal wall, placed in the colon near the resection in the manner described, and carried through the intestinal union into the ileum. It should be so placed that at least one of its perforations would be in the colon while its tip rests in the ileum (Fig. 7).

The series of seven cases of resection of the cæcum and ascending colon herewith reported comprise all the operations of this kind that I have done since January 1, 1908. In all of them the principles of end-to-end union, ligation of the triangular space on the mesenteric border of the bowel before opening the bowel, and cleaning out the ends of the bowel before suturing were carried out, though in only the last case was a valve formed as described. In one case, the Barber operation was performed (W. H. Barber, *Interstate Med. Jour.*, 1917, vol. xxiv, No. 1), transplanting the ileocæcal valve. All of the patients recovered from the operations satisfactorily. An enterostomy was not done in any of these cases, though I believe, in at least two, convalescence would have been more comfortable had it been used. I will add this to the technic in the future.

The last patient, Mrs. G., operated on September 14, 1917, had marked intestinal stasis and thickening of the cæcum and ascending colon and the technic was carried out as described, including the valve formation. This patient was fifty-five years of age and had been an invalid for years, having been confined to bed most of the time for a year and a half previous to operation. She had been treated by a number of very competent physicians in other hospitals and at her home with only slight and temporary benefit. When she entered the hospital for operation she weighed 82 pounds. She began gaining weight about two weeks after operation and within five months gained 36 pounds. She now weighs 115 pounds and is doing her own housework for a family of two (November, 1918). She still has a few nervous symptoms, though they are comparatively insignificant.

Two of the resections were done for intussusception in infants (aged nine and ten months respectively). In one it was impossible to reduce the intussusception; in the other after it was reduced with considerable difficulty the bowel was so damaged that it was thought unwise to leave it. Two of the resections were for stasis in cases in which medical treatment and in one instance two previous operations had failed to give relief. One of these cases, Mrs. G., has been mentioned. In the other, Mrs. M., aged fifty-two, the Barber operation was done and there was marked improvement though not so great as in the case of Mrs. G. In three cases (aged fifty-seven years, twenty-eight years, and sixteen years respectively) resection was done for hypertrophic tuberculosis of the cæcum. One of these

patients has been reported in connection with another group of cases (*Trans. Southern Surg. Association,* vol. xxi, p. 212). In all three the pathologic findings were quite similar. In one, Mrs. D., aged fifty-seven years, it was thought that the growth was cancerous, but gross section and microscopic examination showed typical features of hypertrophic tuberculosis. There was also tuberculosis of several loops of small bowel which were removed. The ileum was united to the stump and then the other affected portion of the ileum was resected (Figs. 8, 9, and 10).

NOTE.—Since this paper was written I have resected the cæcum and ascending colon in another patient, making a total of eight cases of this kind in which this operation has been done. The valve formation and the enterostomy were carried out as described. At present (five days after operation) the patient is making an entirely satisfactory recovery. Her pulse has not been over 104 since the operation. There has been no distension.—J. S. H.

TORSION OF APPENDICES EPIPLOICÆ *

By V. C. Hunt, M.D.
of Rochester, Minn.
(From Division of Surgery, Mayo Clinic)

The appendices epiploicæ appear along the whole of the large intestine except the rectum, where they terminate quite abruptly. They consist of little processes or pouches of peritoneum; no other part of the intestinal wall enters into their formation, the space or sacculation being filled with a variable amount of fat, usually considerable in obese persons. Their shape and size is variable, usually dependent on their fat content. They are often more or less flattened but may be quite cylindrical. When flat they are usually lobulated. Their size is variable along the course of the large bowel and in different persons, the smallest occurring along each side of the mesentery of the appendix vermiformis. The development is moderate on the ascending and descending colon, and the greatest size is usually on the transverse colon and sigmoid flexure. Their length varies from 0.5 to 5 cm., but they have been reported 15 cm. in length (Linkenheld). As a rule but one artery and one vein enter the base of each appendix epiploica. The appendices epiploicæ occur quite evenly in two rows, their line of origin usually being quite close to the anterior and posterior inferior longitudinal muscle bands.

Harrigan quotes Robinson in saying that the physiologic function of appendices epiploicæ is not protective and defensive like the great omentum, as they are simple in structure and present no evidence of specialized function. It is Robinson's belief that these appendices epiploicæ are concerned with the movement of fluids in the large intestine; however, no definite evidence of their true function has been brought to light.

The pathologic changes incident to the appendices epiploicæ are usually those attending mechanical interference with their blood supply either by torsion or direct pressure, torsion being perhaps the only cause within the abdomen—that is, not limited to the abdominal cavity. A considerable number of cases have been reported in which torsion of an appendix epiploica has occurred in a hernial sac, this being the most common site for mechanical interference by direct pressure and strangulation without torsion; however, torsion occurs here also. In either event the interference with the circulation may be suddenly complete or gradually progressive. Fat necrosis is the chief degenerative change, there being frequently considerable inflammatory reaction, particularly in those cases of hernia in which it is manifested by

* Submitted May 15, 1918, to the Faculty of the Graduate School of the University of Minnesota in partial fulfilment of the requirements for the degree of Master of Science in Surgery.

the adhesions which frequently close off the neck of the sac, and by the presence of serum (Servé, Kendirdjy and Sejournet, and Schweinburg cases). Subperitoneal hemorrhagic effusions occur (Lorenz, Zoeppritz, Mohr, Schweinburg, and Linkenheld cases) and at times only small ecchymotic areas with dark discoloration of the appendix epiploica have been seen. In the abdominal cavity these same changes take place, with torsion, and several appendices epiploicæ may adhere over the one in which torsion has occurred, in a way suggesting protection. The affected appendix epiploica then becomes encysted, and fat necrosis and saponification take place until the cyst contains but an oily straw-colored fluid, as was seen in Case A43949.

Since all cases of torsion of an appendix epiploica present acute pathologic processes, characterized by subperitoneal hemorrhagic effusion, fat necrosis, gangrene, etc., infection of the appendix epiploica by direct microbic invasion from the lumen of the bowel because of interrupted continuity, as is seen in diverticulitis of the colon, seems a very probable etiologic factor. Many authors have noted the frequent presence of diverticula in relation to the appendices epiploicæ. Telling says: " Bland Sutton has stated and illustrated by diagrams that this fat is directly continuous with the subserous fat, and if there is any tendency to the formation of diverticula, it will be readily seen that the soft fatty tissue of the appendices epiploicæ form points of lowered resistance." McGrath states that the relationship between diverticula and appendices epiploicæ seems to be due to the fact that these fatty masses are situated either directly on or close to the points where the larger vessels enter the intestinal wall. Greaves reports a case in which there was an active inflammatory process in two appendices epiploicæ of the pelvic colon. They were nodular, black in color, and each one contained a fecal concretion, but no communication with the lumen of the bowel could be found. However, while torsion of these appendices epiploicæ had not occurred, the inflammatory process was undoubtedly due to microbic invasion by way of a diverticulum. Erdmann found, in most of his cases of acute diverticulitis of the colon, involvement of one or more appendices epiploicæ, which were usually very hard and injected or hemorrhagic and becoming gangrenous.

In some of the cases of diverticulitis of the colon with tumor formation seen in the Mayo Clinic, the appendices epiploicæ have been found involved in the inflammatory process in a way suggesting protection to perforation of the diverticula. Virchow's case in which colon bacilli were cultivated from the centre of a foreign body found in the peritoneal cavity, as the sole cause of a peritonitis, adds evidence to the infection theory. Diverticulitis was not found in any of the cases of torsion of appendices epiploicæ reported in the literature, nor was it demonstrated in our cases, yet it seems that infection may prove to be the etiologic factor in the production of torsion and of inflammation in appendices epiploicæ.

Torsion intra-abdominally of an appendix epiploica may suddenly deprive it of its circulation, and with no protection from the omentum or neighboring appendices epiploicæ, necrosis of the narrow pedicle occurs so rapidly that

it drops off and remains in the peritoneal cavity as a free body, encysted by its peritoneal coat. Such fatty bodies have been found in 4 cadavers (Littré, Laveran, Cruveilhier, and Virchow), and in 5 instances at operation (Schede, Neri, Riedel 4, and Case A210428). Of those found in the cadavers, one contained a stone, and in two the foreign bodies were fibrocartilaginous. The case of Virchow showed an atrophied appendix epiploica as a possible source of the foreign body. The foreign bodies found at operation retained their fatty composition in all cases except one (Schede) in which calcification of the body had occurred. These foreign bodies varied in size from the size of a pea to a hen's egg. Colon bacilli were isolated from one of the bodies (Riedel's fourth case) as the source of a fatal peritonitis. In four of these cases operation was done for acute or subacute conditions and nothing else was found to explain the symptoms.

DISCUSSION OF CASES REPORTED IN THE LITERATURE

The literature contains records of forty-two cases which have accumulated under the combined titles of "torsion and inflammation of appendices epiploicæ." It seems advisable to divide these cases into their true classifications, rather than into one large group, according to the pathologic condition presented.

Nineteen were cases of true torsion of an appendix epiploica, intra-abdominal in 9 cases and within a hernial sac in 10. One case of intra-abdominal torsion was a finding at necropsy, the remainder were seen at operation and each presented an acute process. The intra-abdominal cases possessed symptoms of acute surgical conditions in which the diagnosis of acute appendicitis was made in three instances, intestinal obstruction in two, gallstones in one, ovarian disease in one, and appendicitis and gall-bladder disease in one. There were no pathologic findings to explain the acute symptoms, except the torsion of the appendices epiploicæ.

The ten patients with hernias in whom torsion of an appendix epiploica had occurred all had acute symptoms on which the diagnosis of strangulation or incarceration of the hernial contents was made. In twelve cases of hernia in which the symptoms were acute there were from one to three strangulated or incarcerated appendices epiploicæ, showing the inflammatory reaction and fat necrosis attending mechanical interference with blood supply without torsion of the pedicles.

The literature contains accounts of eleven cases of foreign body in the peritoneal cavity which are assumed to have been the results of torsion of appendices epiploicæ, and while evidence in its support is presented in but one case (Virchow) in which there was found an atrophied appendix epiploica the possible source of the foreign body, that assumption is probably correct. However, in the absence of facts establishing these cases as true torsion of appendices epiploicæ, it seems they should not be classified in that group.

One case (Patel) from the report is a true case of diverticulitis, for which the diagnosis is easily mistaken.

Excluding the last 12 cases, the literature contains but 30 cases in which there has been mechanical interference with the blood supply of an appendix epiploica, and in 19 of these it was by torsion. The symptoms in each of these 30 cases were of sufficient severity to require urgent surgical interference.

Several theories regarding the cause of intra-abdominal torsion of appendices epiploicæ have been advanced. Morestin states that for torsion to occur it is necessary that these fatty appendages should be abnormally long and large. Ebner quotes Payr's theory of the difference of length of artery and vein, the vein being the longer by reason of its winding course. In congestion, particularly in stasis with engorgement of the veins, this difference of length may furnish the tendency to the twisting of the pedicle.

Zoeppritz's patient had an adhesion to the omentum, which, on sudden movement in the abdomen, due to a quick turn of the patient, may have been responsible for the torsion of the appendix epiploica. Zoeppritz quotes Küstner, Mickwitz, and Cario as regards external causes, such as peristalsis and variations in the filling of the abdominal organs, contraction of the abdominal muscles and the effect of abdominal pressure, being sufficient to cause torsion of intraperitoneal bodies.

Torsion of an intrahernial appendix epiploica is explained by Ebner in a certain case by its twisting on its exit into the hernial ring at the moment of coughing, similar to the spiral twisting of a cloth used in cleaning a lamp chimney; the tip of the appendix epiploica follows along the wall of the sac, and its base or pedicle remains more or less fixed. In some instances the appendices epiploicæ are carried into the hernial sac with omentum and torsion is produced.

DISCUSSION OF CASES FROM THE MAYO CLINIC

To the cases reported in the literature I desire to add 11 cases which have been under observation in the Mayo Clinic in the past ten years. Seven of these cases are true torsion of the appendix epiploica, 1 is of doubtful torsion, acting as a band producing intestinal obstruction, 2 are of incarceration in a left inguinal hernia, and 1 is of a foreign body in the peritoneal cavity with unproved origin from an appendix epiploica. Four of the cases of torsion presented acute symptoms, for which operation was done, and in the remaining 3 cases the torsion was probably symptomless, as it was found in the course of abdominal operations for other pathologic conditions. The cases in which there was incarceration in a hernial sac presented symptoms of incarceration of the hernial contents. The foreign body was found in the course of an operation for postoperative hernia, and the appendix epiploica, producing the obstruction of the sigmoid, manifested symptoms of chronic intestinal obstruction.

It may be seen from the histories of cases from the literature and those included in our series that intra-abdominal torsion produces symptoms, acute in various degrees, simulating those of gall-stone colic, acute appendicitis, intestinal obstruction, etc., the pain not necessarily occurring directly over the

seat of the lesion, for, while the sigmoid has been the portion of the bowel most frequently affected, the pain has in many instances been in the right abdomen. In the combined series of cases (40) in which mechanical interference with the blood supply to the appendix epiploica had occurred, the origin of the appendix was in the sigmoid in 28 instances, in the cæcum in 6, in the transverse colon in 1, and not stated in 5. Left inguinal hernias are more apt to contain epiploic tags because of the close proximity of the sigmoid, with its long mesentery, to the internal ring of a left hernia. In the 24 cases of torsion or strangulation of the appendix epiploica in a hernial sac, it was found in a left inguinal hernia in 17 instances, in a right inguinal hernia in 5 and in a left femoral hernia in 2.

The amount of torsion of the appendices epiploicæ has varied from one turn through 180° (Zoeppritz) to ten half turns (Adler). It has been stated (Briggs) that torsion of appendices epiploicæ usually occurs in persons more or less obese, during middle life or later. In 24 of the 26 cases of torsion, in which the age was given, the youngest patient was 20 years and the oldest 72, an average age of 45 years—5 each in the third and fourth decades, 4 in each of the fifth, sixth, and seventh, and 2 in the eighth decade.

Intra-abdominal torsion occurred 11 times in the male and 5 times in the female. Within a hernial sac it occurred 6 times in the male and 4 times in the female, the males comprising 65+ per cent. of the entire series of torsion.

ABSTRACTS OF REPORTS OF CASES IN THE LITERATURE

Appendices Epiploicæ as Foreign Bodies

Case I.—In 1703 Littré, during the dissection of a cadaver, found in the abdomen a free, hard, oval body, one inch long. In its center was a round white stone, the size of a pea.

Case II.—In Virchow's case the patient died of peritonitis. A hard, calcified, foreign body was found in the abdominal cavity, the possible source being an atrophied appendix epiploica of the vermiform appendix.

Case III.—In 1894 Schede reported a patient who had symptoms of ileus, and at operation a free body, hard and the size of an egg, was removed from the pelvis and found to be a calcified appendix epiploica.

Case IV.—In 1894, Cruveilhier, at necropsy after death of unknown cause, found a large foreign body, with white, smooth surface, very hard and perfectly free, in the abdomen.

Case V.—In 1895 Laveran at necropsy found a mass of twelve fibro-cartilaginous bodies in the abdomen.

Case VI.—In 1904 Neri found at operation several foreign bodies composed of fat within a connective-tissue envelope.

Case VII.—In one of Riedel's group of cases reported in 1905, the patient had attacks of pain simulating gall-stone colic and a diagnosis of adhesions about the gall-bladder was made. At operation two foreign bodies, almost as large as a cherry, were removed. The pains recurred, and three years later the patient committed suicide. The necropsy revealed two more foreign bodies free in the peritoneal cavity.

Case VIII (Riedel).—The patient was a male, 25 years of age, who four years previously had been operated on for an appendiceal abscess, with removal of the distal end of a gangrenous appendix. He had three indefinite attacks of pain with abscess

formation in the umbilical region. Operation disclosed two small, yellow, round foreign bodies.

CASE IX (RIEDEL).—The patient was a male, 32 years of age, whose symptoms were those of gall-stone colic with jaundice. At operation the gall-bladder contained no stones. The omentum was adherent to the liver and the transverse colon, and two foreign bodies were slightly adherent to it. They were round and calcareous. A number of appendices epiploicæ were hanging by a mere thread from the transverse colon.

CASE X (RIEDEL).—The patient, a female, 41 years of age, had been sick for eight days and presented the symptoms of peritonitis. At operation there were marked signs of peritonitis. A crescent-shaped appendix epiploica, attached to the descending colon, with a flat, grey, foreign body lying free between it and the abdominal wall, seemed to be the sole cause of the peritonitis. The appendix epiploica was not twisted. Colon bacilli were found in the foreign body, which was composed of fat. The patient died on the third day after operation, and necropsy did not disclose any other cause for the peritonitis.

CASE XI (RIEDEL).—The patient had been vomiting for fourteen days, the vomitus at last becoming fecal. A diagnosis of intestinal obstruction was made. At operation a foreign body the size of a bean lay free in the peritoneal cavity. The parent appendix epiploica seemed to spring from the cæcum and was adherent to a coil of small intestine in such a way as to act as a constricting band, the small intestine being greatly distended. The foreign body was composed of fat, and Riedel considered it a part of the appendix epiploica, from which it had become separated by torsion.

Intra-Abdominal Torsion of Appendices Epiploicæ

CASE XII.—In a case of TOMELLINI'S, of a man dead of cardiac paralysis, necropsy revealed that the appendices epiploicæ of the transverse colon and sigmoid were straighter than usual. A flattened appendix epiploica was found the same color as the others, and bound to the mass by a thin pedicle. This pedicle had undergone a true torsion around its long axis.

CASE XIII (RIEDEL).—This patient was a man 40 years of age, who, three days before admission, complained of severe abdominal pain, vomiting, etc., and presented the picture of intestinal obstruction. At operation there was free fluid in the abdomen, the jejunum was greatly dilated, the ileum less so. Arising from the left wall of the cæcum, an appendix epiploica stretched across the ileum and was adherent by its twisted middle portion to the mesentery of a coil of small intestine. The ileum was greatly contracted by the appendix epiploica, acting as an obstructing band, and was relieved by the removal of the appendage. Enterostomy was done to relieve the obstruction. The patient died on the following day and necropsy disclosed peritonitis.

CASE XIV.—BRIGGS in 1908 reported the case of a male, 35 years of age, without a history of previous abdominal complaint. He had had a sudden attack of right lower abdominal pain, which gradually subsided, but increased later in the day. The pulse and temperature were normal. A tumor was palpable over the tender region of the appendix. On the fifth day, with the patient's temperature 100° F., operation was performed. Presenting in the incision was a tumor 1½ inches long and 1 inch wide, having the appearance of a hæmatoma with a peritoneal envelope. It was adherent to the cæcum by a narrow twisted pedicle. The appendix vermiformis, though normal, was removed. The tumor was an appendix epiploica with a twisted pedicle.

CASE XV.—ZOEPPRITZ reported a case in 1909 in which the patient was a male, 20 years of age. For three weeks he had burning pains in the right epigastrium, extending toward the midline. Before examination he had acute epigastric pain and there was tenderness at McBurney's point. The diagnosis lay between acute appendicitis and acute cholecystitis. The appendix vermiformis appeared in the incision and did

not seem to be the cause of the acute symptoms. Upon lengthening the incision a brownish, bluish-red mass the size of a plum appeared in the wound, from the center of which extended a slightly thickened band of omentum. The removed tumor was an appendix epiploica of the beginning of the transverse colon twisted 180°. When the omentum was loosened there was no tendency to untwist.

CASE XVI.—In EBNER'S case reported in 1909 the patient was a male, 65 years of age, who had had a right inguinal hernia for fifteen years and a left inguinal hernia for a shorter length of time. Seven days before examination, after lifting a heavy load, he felt severe pain in the right side of the abdomen. The hernia could be reduced, but three days later there was much hypogastric distention and tenderness, with moderate increase in temperature for two days. Retention of fæces and flatus with vomiting occurred, a diagnosis of intestinal paralysis was made and immediate operation performed. There was a small amount of clear, bloody fluid in the abdominal cavity and a pedunculated fat tag 15 cm. long, arising from the sigmoid and extending from the left inguinal region over to the right side by a thin pedicle, was twisted through 180°. This proved to be an appendix epiploica. As a result of the torsion, congestion and extravasation of blood had occurred in the fat tag. After operation the symptoms of intestinal paralysis were progressive and the patient died on the seventh day. The author explains the intestinal paralysis as being due to the coagulation processes in the mesenteric vessels following torsion of the appendix epiploica.

CASE XVII.—POCHHAMMER in 1910 reported a case of a patient, a male, 34 years of age, who had during the past eighteen years repeated attacks of pain in the right lower abdomen which had been diagnosed as appendicitis. He had a similar attack just before admission to the hospital, with no nausea or vomiting. From the history and examination the diagnosis of appendicitis was made and operation performed. In the pelvis was found a hard, fatty tumor the size of a hen's egg, bluish-black in color and its central portion was infiltrated with blood. It was evidently an appendix epiploica, which had become enlarged from fatty infiltration, and the pedicle had become twisted. The vermiform appendix was shrunken and showed no evidence of inflammation, but was removed.

CASE XVIII.—MORESTIN reported a case in 1912 in which the patient was a female, 30 years of age, who ten days before examination experienced sudden severe left abdominal pain with nausea and moderate temperature for twenty-four hours. Four days after the onset a tender mass the size of a large egg, separate from the uterus, could be felt in the left side of the pelvis. A diagnosis of left tubo-ovarian disease was made and operation performed, at which time atrophy of the uterus and its appendages was found. A mass in the left side of the pelvis in the middle of a few blood clots and recent adhesions, purplish in color, with some attachment to the uterus and broad ligament, had its origin in the sigmoid by a narrow pedicle, twisted upon itself, and proved to be an appendix epiploica. The patient's convalescence was uneventful.

CASE XIX.—KIMPTON reported a case in 1915 of a patient, an obese male, 42 years of age, who had had acute pain in the right lower quadrant of the abdomen, with nausea. He had had one or two previous similar attacks. The lower right quadrant of the abdomen was rigid and tender, the pulse and temperature were normal. A diagnosis of acute appendicitis was made, and at operation a black appendage of fat presented in the region of the appendix vermiformis, which was a twisted appendix epiploica. It was removed, and, although the vermiform appendix was normal, appendectomy was done. Further abdominal exploration was negative. The twisted appendix epiploica was hemorrhagic and necrotic. The convalescence was uneventful.

CASE XX.—HARRIGAN in 1917 reported a patient, a male, 29 years of age, who two days before examination had sudden severe pain in the right lower quadrant of the abdomen, with no radiation, which became progressively worse in spite of the use of opiates. Physical examination was negative except for a slight rigidity and tenderness over McBurney's point. The temperature was 100° F., pulse 98 and respiration 24.

A diagnosis of acute appendicitis was made and immediate operation performed. The vermiform appendix was not inflamed and general exploration of the abdomen was negative except in the sigmoid, where an appendix epiploica presented evidence of acute inflammation, the pedicle being twisted. The appendix epiploica was removed by ligation of its pedicle and the vermiform appendix removed, with the patient's complete recovery.

Intrahernial Torsion of Appendices Epiploicæ

CASE XXI (RIEDEL).—The patient was a female, 20 years of age, who had had a left reducible femoral hernia for ten years and an irreducible right femoral hernia for a few months. On the day before examination the patient had violent abdominal pain with tenderness of the left femoral hernia. At operation the next day a fatty structure 1 cm. by 5 mm. was found suspended from the wall of the sac by a thin pedicle of fibrin. The case seems to have been one of torsion.

CASE XXII (RIEDEL).—The patient was a female, 56 years of age. For two years she had had a right inguinal and a left femoral hernia. Two days before admission to the hospital the patient suffered with severe pain in the left groin, and the femoral hernia was then an irreducible tumor. Immediate operation showed an appendix epiploica twisted once on its axis and adherent by its distal extremity in the hernial sac. Necrosis had already begun. The pedicle was ligated and the appendix epiploica removed, with radical cure of the hernia and recovery.

CASE XXIII.—SERVÉ in 1906 reported the case of a male patient, who had had a left inguinal hernia for many years in which two days before examination he experienced a violent pain following a severe muscular effort. The scrotum was swollen, and at operation a few drops of fluid escaped from the hernial sac which revealed as the content an appendix epiploica 10 cm. long, completely twisted on itself. This was removed and radical cure of the hernia was followed by recovery.

CASE XXIV.—MUSCATELLO in 1906 reported a case of a patient, a male, 38 years of age, who had experienced a sudden pain in the left inguinal region six months previously, the pain disappearing for a month. He had a left inguinal hernia extending into the scrotum, which at operation contained omentum in the sac and an appendix epiploica adherent to the posterior border of the neck of the sac and twisted on itself. The torsion occurred 5 mm. from the insertion of the appendix epiploica on the colon. Removal of the appendix epiploica and radical cure of the hernia were followed by recovery.

CASE XXV.—In 1907 MOHR reported a case of a patient, a male, 62 years of age, who had had for the past three to four years a reducible tumor of the left inguinal region, which ten days before examination became irreducible. On the diagnosis of strangulated hernia operation was performed, and in the hernial sac an appendix epiploica was found which presented hemorrhagic infiltration. The tips of two other appendices epiploicæ presented in the sac, springing from the sigmoid, and were in a state of torsion with gangrene imminent. They were removed; the patient recovered.

CASE XXVII.—KRÜGER reported in 1907 the case of a patient, a male, 56 years of years of age, had a right inguinal hernia, much abdominal pain and symptoms of intestinal obstruction. Operation revealed in the hernial sac, among loops of intestine and inserted mesially to the neck of the sac, a narrow, tense, pseudo-ligament about 6 cm. long, and around which an appendix epiploica, arising from the colon, had become twisted and strangulated, torsion being through 360°. The immediate visceral and parietal peritoneum was covered with fresh fibrin, and the twisted appendix epiploica showed subperitoneal effusions of blood and gangrene of the pedicle at the point of strangulation. The band and appendix epiploica were resected, with good recovery.

CASE XXVII.—KRUGER reported in 1907 the case of a patient, a male, 56 years of age, who had had an attack of pain in the right groin twenty years before, which disappeared after a few weeks, to recur two years previous to admission to the hospital

and again four days previously. The pain radiated from the urethra to the umbilicus. There was a firm mass in the right inguinal region, which, at operation, proved to be an appendix epiploica 4 cm. by 1.5 cm., springing from the cæcum by a short pedicle, which had passed through the inguinal canal and become twisted in the hernial sac, giving rise to the inflammatory symptoms. The appendix epiploica was removed, with radical cure of the hernia.

CASE XXVIII.—In 1908 ADLER reported a case in which the patient, a robust woman, 72 years of age, had had a left reducible inguinal hernia for twenty years. The day before admission to the hospital the hernia became irreducible. An operation was done immediately and a cord-like mass lying in an œdematous sac was found. The mass was of omental tissue, which ended below in an enlargement the size of a chestnut. The cord was twisted on itself and contained ten half turns, the whole lying quite free in the hernial sac. On following the cord down, it was found to have its origin from the large intestine and proved to be an elongated twisted appendix epiploica. The hernia was repaired and there was an uninterrupted recovery.

CASE XXIX.—In 1908 LINKENHELD reported the case of a patient, a fleshy man, 64 years of age, in whom eight days previously a painful, irreducible swelling had appeared in the right inguinal region. A diagnosis of strangulated omental hernia was made. At operation the hernial contents were found to consist of omentum and a twisted connective-tissue cord extending up into the abdominal cavity. This was ligated and the omentum removed, with radical cure of the hernia. The patient died on the sixth day from gastric hemorrhage, and necropsy showed multiple ulcers of the stomach; also six long, thick and fat appendices epiploicæ of the sigmoid were found with the tied pedicle of the cord in the hernial sac.

CASE XXX.—In 1910 KENDIRDJY reported a case of a patient, a male, 43 years of age, who had had a left inguinal hernia for twelve years. Two weeks before examination severe pain in the hernia and swelling were noted. Two days before examination symptoms of intestinal obstruction appeared and the skin overlying the hernia was inflamed and tender. When the hernial sac was opened, some yellow fluid escaped, and a yellow fatty mass, presenting ecchymotic areas, formed its contents. This was attached to the sigmoid by a pedicle, in which torsion one and one-half times had occurred. The pedicle was ligated, with radical cure of the hernia and recovery.

Intrahernial Strangulation or Incarceration of Appendices Epiploicæ

CASE XXXI.—In 1906 VON BRUNS reported the case of a patient, a female, 55 years of age, who had had a left inguinal hernia for four years. It became suddenly painful, swollen and irreducible, the overlying skin becoming red and œdematous. At operation a small amount of fluid escaped and revealed a gangrenous strangulated appendix epiploica, which was removed, and good recovery occurred.

CASE XXXII.—MUSCATELLO reported a case in 1906 of a patient, a female, 56 years of age, who was suddenly attacked by violent femoro-inguinal pain on the left side, radiating all over the abdomen and in which the diagnosis of strangulated femoral hernia was made. Operation under local anæsthesia allowed the escape of clear yellow fluid and the exposure of two appendices epiploicæ, measuring 2 and 1.5 cm., respectively, attached by narrow pedicles to the sigmoid. The appendices epiploicæ were removed and the sac resected, with a radical cure of the hernia and recovery of the patient.

CASE XXXIII.—In 1906 SCHWEINBURG reported the case of a patient, a male, 45 years of age, who had had a reducible left inguinal hernia for years. Six days before admission to the hospital the hernia became irreducible and painful and tender. At operation the hernial sac contained odorless fluid and three appendices epiploicæ, which were thickened and hemorrhagic, and, on being drawn down, were found to have their origin from the sigmoid. They were removed, with radical cure of the hernia and recovery.

CASE XXXIV.—VERGA reported a case in 1907 of a patient, a female, 46 years of age,

who developed a right inguinal hernia at 23 years of age and a left inguinal hernia at 26, both of which remained reducible until eight days before examination, when the left hernia could not be reduced. There was some pain from it, radiating to the hypogastrium, but no nausea, vomiting or evidence of intestinal obstruction. In the left inguinal region there was a mass the size of an almond, which was tender. On the diagnosis of an irreducible hernia, operation was performed November 4, 1906, at which time two appendices epiploicæ were found strangulated in the hernial sac, showing vascular engorgement and several hemorrhagic points. They originated from the sigmoid. They were ligated and cut off and the hernia repaired, with good recovery.

Case XXXV.—Vulliet reported a case in 1907 of a patient, a male, 62 years of age, who had had a double inguinal hernia for twenty years. There was severe pain in the left inguinal region three days before admission to the hospital. At operation the left hernial sac contained two appendices epiploicæ with thin pedicles extending to the sigmoid. Removal of the appendices epiploicæ and radical cure of the hernia was followed by recovery.

Case XXXVI.—In 1907 Smoler reported a case of a patient, a male, aged 37 years, who, on admission to the hospital, complained of nausea and weakness, and who had noticed two days previously that a right inguinal hernia was no longer reducible. On examination the patient was found in a state of moderate shock and an operation was done immediately. The hernial sac was thick and contained bluish-red discolored omentum, with incipient necrosis due to torsion of 360° of that part of the omentum. By the side of the omental mass, at the median side of the hernial aperture, a structure as thick as the finger and 2 cm. long presented, which proved to be an appendix epiploica of the sigmoid. The omentum and appendix epiploica were removed, with death of the patient on the fifth day.

Case XXXVII.—In 1908 Linkenheld reported the case of a female, 57 years of age, in whom there appeared, eight days before examination, a swelling in the right inguinal region which caused severe pain. The swelling was firm and tender. At operation strangulated in the neck of the hernial sac was a piece of fat the size of a hazelnut. After freeing the adhesions the fat tag could be withdrawn. It exhibited a distinct constriction and proved to be an appendix epiploica, probably of cæcal origin.

Case XXXVIII (Linkenheld).—The patient, a male, 71 years of age, had had a left inguinal hernia for a year, in which, two days before admission, pain, swelling and reddening of the skin occurred, with no symptoms of obstruction. The hernia was tender to pressure. At operation the contents of the hernial sac consisted of three appendices epiploicæ, one the thickness of the finger and the other two the thickness of a lead pencil. They were swollen, reddened and infiltratd with blood, being strangulated at their upper ends. Two days later the patient died from ruptured aneurysm, as revealed at necropsy, which also showed enlarged appendices epiploicæ of the descending colon and sigmoid.

Case XXXIX.—Tisserand in 1908 presented a report of a patient, a male, 36 years of age, who had had a left inguinal hernia all his life, which the past year had at times been painful and irreducible. Sixteen hours before examination he had had a violent colic in the hernia, with some nausea, but no vomiting. Immediate operation disclosed two appendices epiploicæ in the hernial sac, with some free fluid. One appendix epiploica was not strangulated, but the other was swollen, ecchymotic, and in the process of becoming gangrenous from strangulation. Its origin was probably from the cæcum. These appendices epiploicæ were removed, the hernia repaired and the patient had an uneventful convalescence.

Case XL.—Truffi in 1908 reported the case of a patient, a female, 45 years of age, who, about a year previously, noticed a swelling in the left groin, which appeared suddenly and remained for a week. Eight days before examination the swelling recurred. It was painful to pressure, the pain gradually subsided, but the swelling persisted. On admission to the clinic it was the size of a hen's egg and was not

reducible. A diagnosis of irreducible hernia was made, and at operation the sac was found to contain a small amount of dark-red liquid and two club-shaped fat bodies, which were covered with numerous hemorrhagic points, and proved to be appendices epiploicæ strangulated at the neck of the sac. They probably originated from the sigmoid. They were removed and the hernia repaired.

CASE XLI (TRUFFI).—The patient, a male, 75 years of age, had had a double inguinal hernia for forty years; the left disappearing of its own accord and the right by operation two years previously. About two months before examination he had had severe pain in the left inguinal region with recurrence of the left inguinal hernia, which was irreducible, with a sense of pressure and pain. Operation was advised. In the sac of the hernia were found two appendices epiploicæ, with strangulation of their pedicles in the neck of the sac. Convalescence was uneventful.

CASE XLII.—In 1912 PATEL reported the case of a patient, a male, 45 years of age, who had had a left inguinal hernia for twenty years. Eight days before admission to the hospital the hernia became irreducible and painful. The overlying skin was red and œdematous, as was the scrotum. The symptoms continued and a diagnosis of strangulated hernia was made. An incision of the hernial sac allowed the escape of a sero-purulent liquid. An appendix epiploica was strangulated in the hernial sac. The tag was ligated and removed. The end of the pedicle had a lumen communicating with the lumen of the large intestine, which proved to be a diverticulum into the appendix epiploica.

CASES FROM THE MAYO CLINIC

True Intra-abdominal Torsion of Appendices Epiploicæ

CASE XLIII (A8716).—R. A. K., a male, fifty-eight years of age, was admitted to the Clinic April 10, 1908. The previous history was negative except for severe constipation for years. Two weeks previously pain was noticed on defecation; there was some mucus in the stool but no blood. The pain continued and was aggravated by enemas. There were no other subjective symptoms. A mass could be felt per rectum, and the diagnosis of a tumor of the sigmoid was made.

Operation was performed April 15, 1908, and an appendix epiploica with a twisted pedicle was found. The pedicle had its origin about five inches above the rectum, and the appendix epiploica had dropped to the bottom of the pouch of Douglas, forming a cystic and adherent mass the size of an orange. The appendix epiploica was removed, with recovery of the patient.

CASE XLIV (A6851).—A. Mc., a carpenter, forty-three years of age, was admitted to the Clinic April 26, 1910. Less than a year previously he had had an appendectomy with negative exploration of the gall-bladder. The history of the present complaint was pain in the right side of the abdomen opposite the umbilicus for four years, very severe at the onset, the patient being in bed four days at that time with diarrhœa and vomiting. The symptoms recurred every two or three months. Appendectomy was performed less than a year previous to examination with recurrence of a similar attack two months later. During the past six months the attacks had been more frequent, the pain lasting from five to six hours and always accompanied by diarrhœa. There was no disturbance of the bowels between attacks, and no radiation of pain. At times there were spells of indigestion, but never any symptoms of organic disease of the stomach or duodenum. Seven days before admis-

sion the patient had had a severe attack of left lower abdominal pain accompanied by vomiting of four hours' duration, and requiring morphine to control. The general physical examination, urinalysis, X-ray examination of the kidneys, ureter and bladder, and cystoscopic examination were all negative.

May 3, 1910, exploration was made of the stomach, gall-bladder and left ureter. These proved negative, but a twisted appendix epiploica of the sigmoid, with its circulation completely cut off, was found. There also were adhesions of the terminal four inches of ileum to the lateral abdominal wall; these were divided and the appendix epiploica removed. Within the next four months there were several recurrent attacks of pain; the further history of the case is not known.

Case XLV (A38941).—Mrs. F. L., aged twenty-nine years, was admitted to the Clinic June 14, 1910. For seven years the patient had had attacks of moderate pain in the right lower abdomen, usually of only a few minutes' duration, and never severe enough to keep her from her work, but at times they had been of the nature of a dull ache for a day at a time. During the two months preceding examination, there had been moderate digestive disturbance but never any acute attacks of pain. A diagnosis of chronic appendicitis and cholecystitis was made.

June 20, 1910, operation was performed and chronic adherent appendix, and an appendix epiploica, the size of a small pecan, with a twisted pedicle, were found and removed. Exploration of the gall-bladder and stomach was negative.

Case XLVI (A69658).—Mrs. J. J., aged sixty-three years, was admitted to the Clinic June 24, 1912. The patient had been perfectly well until three months previously, at which time she was confined to bed with burning pain and cramps in the left lower abdomen and much localized tenderness. This had been more or less constant, with the pain radiating around to the sacral region. Constipation, walking, and working aggravated the trouble. Physical examination disclosed tenderness in the left abdomen, moderate œdema of the legs, due to large varicose veins, and complete uterine prolapsus with rectocele and cystocele. X-ray of the kidneys, ureters and bladder was negative.

July 3, 1912, because of the complaint referred to the left lower abdomen, an abdominal operation was done. A calcareous appendix epiploica of the sigmoid, with a twisted pedicle was found. Other exploration of the abdomen was negative. The appendix epiploica was removed and a Kocher abdominal operation done for the prolapsus.

Case XLVII (A162332).—Mrs. J. B., seventy years of age, was admitted to the Clinic June 10, 1916. Three years previously the patient began having occasional uterine bleeding for a few days at a time, which continued for a year. For two years the discharge had been scant, and six months watery in character. The uterus was enlarged. The menopause had occurred when she was 48 years of age.

June 14, 1916, total abdominal hysterectomy with removal of both ovaries and tubes was done for carcinoma of the body of the uterus and multiple fibroids. Two appendices epiploicæ with twisted pedicles, making a mass the size of the thumb, were found and removed. These were

reported by the pathologist to be hemorrhagic. There had been no history of a recent acute abdominal complaint.

Case XLVIII (A181741).—P. B., a male, aged thirty-seven years, was first seen January, 1917. One month previously the patient had had sudden, severe pain in the left lower abdomen with much localized tenderness which had partially subsided a few days before examination. The patient was a large man who had lost 20 pounds in weight since the onset of the complaint. The urinalysis, blood, and X-ray examination of the colon were negative. A diagnosis was made of probable diverticulitis.

Operation was performed January 5, 1917. A general exploration of the abdomen showed the small intestine and the gall-bladder to be normal, the appendix small, short and normal, and the sigmoid markedly thickened with one epiploic tag about 1¼ inches long and ¾ inch wide, twisted on its pedicle. Fat necrosis had occurred and the appendix epiploica had become adherent to surrounding epiploic tags. The tags which were involved in the inflammatory mass and the one undergoing necrosis were removed and their stumps ligated. There was no evidence of diverticulitis.

Case XLIX (A43849).—Mrs. E. A. H., fifty-one years of age, was admitted to the Clinic November 7, 1917. The patient presented herself for examination because of a troublesome watery vaginal discharge, for which hysterectomy was advised. There were no symptoms of an acute abdominal process. She had passed the menopause at thirty-six years of age.

November 12, 1917, total abdominal hysterectomy with removal of both ovaries and tubes, for chronic metritis of the precancerous type, was done. An appendix epiploica of the sigmoid appeared in the wound. It was a round body about 2 centimetres in diameter and was twisted on its pedicle. It had become encysted and contained a clear, straw-colored fluid and oil. There was nothing in the patient's history to indicate that it had produced subjective symptoms.

Appendices Epiploicæ as Foreign Bodies

Case L (A210428).—Mrs. C. B., aged forty-two years, was examined October 8, 1917. The patient who was very obese had had six operations for appendicitis, uterine prolapse, and postoperative hernia, the last one six years ago. For the past four years there had been more or less lower abdominal pain which she thought due to adhesions. She presented herself for the repair of the postoperative hernia.

November 28, 1917, a large postoperative hernia was repaired. A tumor was found free in the pelvis, 4 by 3 by 3 cm. This proved to be a sac containing degenerated fat, probably an appendix epiploica which had become twisted from its attachment to the large bowel.

Incarceration of Appendices Epiploicæ in Hernial Sacs

Case LI (172141).—G. G. B., a male, sixty-three years of age, was examined September 12, 1916. Nine months previously the patient had developed soreness in the left lower abdomen with the formation of a

mass which had persisted and the soreness had been aggravated by exertion. There were no other subjective symptoms. The patient was obese. On physical examination a small mass was palpable above the left internal inguinal ring and there was, separate from this, a left inguinal hernia. Urinalysis, blood, and X-ray examination of the colon were negative.

September 18, 1916, abdominal exploration was done through a low left rectus incision. No disease other than the tumor mass was revealed. This apparently came and went as the sigmoid which was held tightly against the left internal inguinal ring became blocked. A large incarcerated mass of omentum which was undergoing necrosis was found in the hernial sac, dissecting its way between the muscles and fascia. Adherent appendices epiploicæ of the sigmoid were also contained in the hernial sac, which held the sigmoid in a fixed position. The omentum was divided and the sigmoid separated from its adhesions. The hernial sac and contents were removed and the internal ring closed with mattress sutures.

Case LII (A186645).—A male, aged fifty-one years, was examined February 24, 1917. The patient had been perfectly well until one week previously when, after lifting a heavy load, he experienced pain in the left groin and a swelling formed which had remained painful and had caused some nausea. Physical examination was practically negative except for a firm irreducible mass 1½ inches by 1 inch in the region of the left external inguinal ring.

At operation March 13, 1917, an incarcerated appendix epiploica of the sigmoid was found in a left inguinal hernia. The appendix epiploica was excised and the hernia repaired.

APPENDIX EPIPLOICA PRODUCING INTESTINAL OBSTRUCTION

Case LIII (A49009).—C. G. G., a male, aged fifty-seven years, was examined February 8, 1911. The patient's health was in fair condition until eight months previous to examination, when he had had a sudden attack of pain in the left lower abdomen, with much distention followed by soreness for six or seven days. A month later he had a similar spell. Three months later he had a very severe attack with symptoms of intestinal obstruction for seven days. He was in bed fourteen days, during which time there was much pain, tenderness and rigidity in the region of the umbilicus, with apparent obstruction in the left lower abdomen. Morphia and chloroform were used to control the pain. The last severe attack was eight weeks before, but the lower abdominal soreness persisted up to the time of examination. There was never any blood in the stool. The patient had lost about 30 pounds in weight; otherwise the general physical examination was negative. A diagnosis of chronic intestinal obstruction, with possible carcinoma of the sigmoid, was made.

Operation February 13, 1911, revealed obstruction of the sigmoid by a band due to a long appendix epiploica which was adherent across the top of the sigmoid near its middle. Over this a loop of the sigmoid had dropped causing a rather tight obstruction. The band was divided and appendectomy done for acute appendicitis.

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LEGG'S DISEASE

ARTHRITIS DEFORMANS JUVENILIS: OSTEOCHONDRITIS DEFORMANS JUVENILIS: "PERTHES'S" DISEASE

By Leonard W. Ely, M.D.

of San Francisco

Under the title, "An Obscure Affection of the Hip Joint," Arthur T. Legg, of Boston, reported before the American Orthopædic Association, in 1909, a series of observations on five cases of a disease not previously identified, and published his paper in 1910.[1] His report was brief, accurate and scientific. Very little definite has since been added to it.

In 1910, Perthes,[2] of Tübingen, reported cases of the same disease, without recognizing their nature, publishing them as cases of Arthritis Deformans Juvenilis; that is, as cases of "arthritis deformans" in the young. In 1913 Perthes recognized that the disease bore little resemblance to what the Germans call arthritis deformans. Evidently he overlooked Legg's original paper. He excised from one patient a piece of the synovial membrane, and a piece of the head of the femur. The synovial membrane showed no sign of inflammation; therefore Perthes rightly concluded that the disease was not an arthritis. Neither the bone nor the cartilage showed evidence of inflammation, yet Perthes calls his "new" disease Osteochondritis Deformans Juvenilis.[3]

Since 1913 many others in this country and in Germany have reported cases of the disease, and gradually the name Perthes's Disease has been adopted for it. A half-hearted attempt has been made in America to give Legg due credit, but I have never seen his name mentioned in the German periodicals. As the American Orthopædic Association is not a secret society, nor the *Boston Medical and Surgical Journal* an obscure periodical, one notes with amusement or irritation the recurrence of an oft-observed phenomenon.

Following is a report of five cases, with an abstract of their histories. Most of them were thoroughly worked up, and any possible source of infection was sought for.

Case I.—F. A., six years old, December 31, 1914. Pain in right knee, limp. Abduction markedly limited. Positive von Pirquet test. Treatment: Short plaster spica for about six months. Since then no

[1] *Boston Medical and Surgical Journal*, 1910, clxii, 202.

[2] Perthes, "Deutsche Zeitschrift für Chirurgie," 1910, cvii, 111.

[3] Perthes: *Archiv f. klinische Chirurgie*, 1913, ci, 779. "Die Synovalis .... zeigt sich völlig unverändert .... Microscopisch zeigt der Gelenkknorpel das Bild des hyalinen Knorpels mit überall guter Kernfärbung. In dem darunter liegenden Knochen fallen zahlreiche Knorpelinseln auf, mit unregelmässig zackiger Begrenzung. Die grösste dieser Knorpelinseln liegt dicht unter dem Gelenkknorpel und ist mit dieser durch einen dünnen Stiel verbunden..... In den Zwischenräumen zwischen den Knorpelinseln finden sich normale Knochenbälkchen und von diesen eingeschlossen auffallend weite, mit Fettmark ausgefüllte Markräume. *Zeichen entzündlicher Infiltration finden sich nicht.*"

treatment. Patient disappeared, and was brought for examination by request in December, 1918. He is said to limp slightly when he is tired. He walks well but has a slight exaggeration of his lumbar lordosis. His trochanter is prominent. Abduction is slightly limited. Flexion limited to 90°.

CASE II.—C. I., thirteen years old, May 5, 1914. Pain in right hip following a fall five months previously. Ecchymosis was present at that time and swelling. The boy has limped ever since. Examination showed three-quarters of a centimetre lengthening, and a positive Ely's sign on both sides. The incisors were irregular, without enamel near the point, and with " shoulders." The von Pirquet test was positive, the Wassermann test negative. The boy was undersized and underdeveloped. (Under thyroid extract he grew one inch in five weeks.) Treatment: Plaster spicas. After treatment for eight months the right lower extremity was one and one-half centimetres longer than the other. The patient had also antiluetic treatment for a long time. There was no note of pain on the left side, but involvement of the left hip was discovered in April, 1915, and shortly after that the adductors were stretched under ether and a double spica was applied in abduction. June, 1915: " Cannot move right hip at all." The plaster was removed in February, 1916. Brought by request November, 1918. No limp is present. The boy is said to walk and play normally. The trochanters are prominent. The lower extremities are of equal length. The right hip is limited in flexion to a right angle, decidedly limited in abduction, and slightly limited in extension. The left is a trifle limited in flexion, and somewhat in abduction. In spite of the comparatively good functional result, the skiagram shows marked double coxa vara, and great distortion of the head and neck. It is seen, from a study of the skiagrams, that nothing characteristic is present in the left hip. A positive diagnosis of Legg's disease on that side cannot be made, and yet the outcome is practically the same.

CASE III.—W. L., aged eight years, April 28, 1917. Pain and limp for two or three weeks with history of injury six months previously. This was followed by complete recovery.[1] Three months previous pain in left thigh and limp, continuing to date. Examination showed a limp. The hip is in slight flexion and abduction. Extension, adduction and especially abduction limited. Flexion is free. Treatment: Short plaster spicas for about a year, then a brace. Now apparently well, December, 1918, with a free range of motion, except abduction, which is slightly limited.

CASE IV.—B. P., aged nine years, April 5, 1916. Pain in right shin following injury to knee four months ago while playing top.[2] Restriction of motion at extremes in all directions. Limp. Negative Wassermann. The tonsils contained pus, and were removed. Treatment: Short spicas from May 2, 1916, to April 5, 1917. December, 1918: No limp, trochanter prominent. Hip goes into abduction on forced flexion and abduction is perhaps a trifle limited. Otherwise complete recovery.

[1] Probably the boy sprained his joint already damaged by the characteristic changes, and his sprain grew well.

[2] Observe the forced sequence of cause and effect.

FIG. 1.—Case I. Final skiagram, December, 1918. The plate taken at the first examination is lost. Note flattening of head and lateral displacement, and decrease in density of upper and lateral part of neck. Thickening of neck.

FIG. 2.—Case II. Skiagram taken at first examination, May, 1914. Flattening and irregularity of head, irregularity and lack of definition of epiphyseal line. Irregularity of upper border of neck.

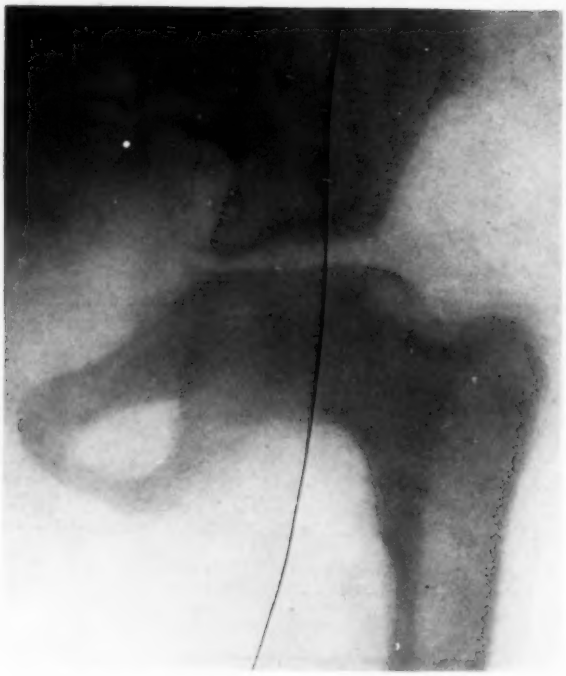

FIG. 3.—Case II. January, 1915. Increased irregularity of head, with segmentation and lateral displacement. Increase in density of neck and of intertrochanteric part of femur.

FIG. 4.—Case II. April, 1915. Outline of head is smoother, but head is segmented, and its lateral displacement is more marked. Scarcely anything is to be seen in the left hip.

FIG. 5.—Case II. February, 1916. Irregularity of acetabulum on right side. Head of femur flattened, broadened, and irregular in outline. Neck short, thick, and dense. Still nothing characteristic on left.

FIG. 6.—Case II. November, 1918. In right hip the disease has reached its typical end in spite of treatment. On the left, though no definite picture of Legg's disease has been present, it is indicated by the well-marked coxa vara.

FIG. 7.—Case III. April, 1917. Flattening of head, and irregularity of ossification. Irregularity of epiphyseal line.

FIG. 8.—Case III. December, 1917. Little change in head of bone. Area of decreased density in upper, medial part of neck.

FIG. 9.—Case III. May, 1918. More extensive irregularity of the head of the bone. If this irregularity represented actual bone destruction, the stump of the neck would be applied close to the acetabulum, instead of being at a distance from it.

FIG. 10.—Case III. October, 1918. The head is becoming more uniform in texture and outline. This could not be, if it had been destroyed.

FIG. 11.—Case IV. April, 1916. Flattening and slight irregularity of the head, with some widening and irregularity of ossification of proximal part of the neck of the femur, in a sort of band near the epiphyseal line.

FIG. 12.—Case IV. December, 1917. Marked segmentation of head, with obliteration of any formal epiphyseal line. Irregular ossification of neck in the vicinity. Thickening of neck.

FIG. 13.—Case IV. November, 1918. Wider separation of head fragments. Increase of width of neck. Slight decrease in irregularity of ossification of neck. With this striking picture the hip is practically well.

FIG. 14.—Case V. May, 1917. Flattening, broadening, irregularity and segmentation of head, with lateral displacement. Thickening of neck.

FIG. 15.—Case V. February, 1918. Little change. Neck a trifle thicker.

FIG. 16.—Case V. September, 1918. Some increase in density of bone.

CASE V.—A. R., aged eight and a half years, November 17, 1915. Complaint: Limp, and pain in groin. "Probably negative" von Pirquet. Examination showed slight limp. Abduction practically nil. This and the preceding case had the peculiar sign of abduction in flexion of the hip. One-fourth inch shortening. Tonsils showed pus in crypts and were removed. Short spicas from April 7, 1915, to June 13, 1917. December, 1918: No limp, no deformity. Slight limitation of abduction and adduction. Less than one-half inch shortening.

Until the opportunity is afforded of examining some specimens in the laboratory, we shall lack definite knowledge of the disease, but the following facts, theories, and conclusions may be interesting.

Legg's disease is an error in development of the whole upper epiphysis of the femur—trochanter, neck and head. In this the acetabulum sometimes shares. It affects chiefly the head and the proximal lateral portion of the neck, and the cartilage between them. The great trochanter may or may not be involved.

It possesses a strong congenital element. It is first observed between the ages of five and ten.[1] It is thought to affect boys more often than girls, in the proportion of 4–1; but, counting the cases observed with congenital hip dislocation, the disproportion is probably not marked.

It is often seen after reduction of congenital hip dislocation, occasionally on the sound side.[2]

It is frequently bilateral, with symptoms only on one side.

In two cases a growth of staphylococcus has been recovered at operation from a softened area in the neck. One case showed a "necrotic" area, the other a "grayish" condition of the marrow. The pathological reports in these cases leave much to be desired. No evidence of an arthritis ever has been adduced.

It is hard to explain its causation by circulatory disturbances. Trauma probably does not cause it, but simply acts by spraining the distorted joint. Trauma often causes the symptoms but not the disease. Witness the frequent bilateral nature and the fact that almost invariably the X-rays show the complete and definite picture at the first examination. Then, in spite of treatment, or without treatment, the affection pursues a definite course, which no trauma would explain. This course may be modified by correct treatment, and the resulting deformity (coxa vara) avoided.

The areas of "destruction" (so-called), shown by X-rays, in the head, may possibly be areas of unossified cartilage. It is not likely that a destructive inflammation in the marrow of the head and neck could exist without symptoms, and without causing an arthritis, except as a great rarity. These irregular patches are standard in Legg's disease, occur with or without symptoms, and are present after healing apparently has occurred.

The typical Röntgen picture consists in: (1) A flattening, broadening,

[1] In this connection the fact that the patient in Case 2 was markedly underdeveloped is extremely interesting. At 13 years he appeared to be about 8.

[2] Perthes, Brandes.

and sometimes an apparent displacement of the epiphysis laterally, with one or more divisions of it and irregularity of ossification. (2) An irregularity or even segmentation of the cartilage between it and the neck. (3) Loss of bony structure in the neck, especially of its proximal and lateral part.[1] (4) Irregularity in contour of the upper part of the femur neck. (5) Distortion of the head. (6) Enlargement of the trochanter (occasionally). (7) Irregularity of the acetabulum—not characteristic.

The astounding difference between the marked changes in the X-ray picture and the comparative insignificance of the symptoms and physical signs is characteristic.

The interesting query presents itself: Are all these changes due to some one special cause, or is one of them the essential change, and all the other changes its result?

The later picture shows a short thick neck, often coxa vara, and a distorted head. The chief symptoms, when symptoms are present, are limp and pain. Examination shows the limp, a prominent trochanter, and limitation, especially of abduction. Other motions may or may not be limited. A peculiar sign is the abduction at the hip when flexion is forced.

The affection seems to run its course in two or three years. Its most active period is one year. Even after all symptoms have subsided and a cure evidently has been obtained the X-ray may show an alarming picture.

Fibrous or bony union of the joint never occurs. The restriction of motion is mechanical.

In the past, Legg's disease often has been mistaken for tuberculosis, and cases of it have been quoted to swell the list of cures by some favorite treatment. The diagnosis as a rule is not difficult. Tuberculosis has more pain, more muscular spasm, greater restriction of motion and greater muscular atrophy. It shows radiographically more involvement on the shaft side of the epiphysial line and less in the head of the bone. It has not the same disproportion between the X-ray picture and the symptoms and physical signs.

As infection cannot be ruled out, any possible focus of infection in the body may be removed.

A good treatment consists in reduction of the deformity, if necessary under anæsthetic, and the immobilization of the fully abducted hip in a short plaster spica until the process has run its course and the neck has firmly solidified. Crushing of the head is not to be feared.

Finally, as Legg described Perthes's disease three years before Perthes, the justice of calling it Legg's disease seems sure.

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NOTES ON THE USE OF RUBBER GLOVES IN SURGICAL OPERATIONS*

By Robert T. Morris, M.D.

of New York

At the present time the employment of rubber gloves in surgery belongs practically to a settled question. Let us for a moment take up for examination several features of the subject—which are now covered by a blanket of accepted custom. In my opinion the development of the rubber glove in its application to practical work has represented one of the most important advances ever made in the field of surgery. Full credit is due the surgeons who have fought their way with the merits of the rubber glove against the forces of the opposition—some of which forces had genuine purpose; other and larger ones related perhaps to inertia and indifference on the part of a profession which needed to be led on with determination to correct methods. Because of the psychology of the situation we sometimes find in our profession that, by the time there is full acceptance of or agreement upon any one subject, it is out of date. At the time when I stood openly against the employment of rubber gloves, thick and ill-fitting gloves were the only ones obtainable. I saw much bungling work done by my assistants and by skilled surgeons. I feared for the future of surgery with a lost *tactus eruditus*—that sense of touch lauded since the earliest days in the history of medicine and estimated at its true value by skilled surgeons at the time of the introduction of the rubber glove.

What are the basic principles involved? Rubber gloves can be sterilized readily and completely. Well prepared hands commonly carry not only a few free bacteria but also nests of bacteria, hidden in the epithelium, which may be liberated when the hands become softened with blood serum. The surgeon working with rubber gloves requires on the whole rather longer incisions than those required by the surgeon working with the sense of touch; and this brings us to the question as to whether the bacteria carried into the wound by the surgeon's hands are more harmful than those which fall in from the air during the course of an operation. Petri plates carrying culture media and exposed in the best of operating rooms become infected from the air after fifteen minutes' exposure. On the other hand, we know that fresh blood serum exerts an inhibitory influence upon any bacteria which are carried into the wound either by the surgeon's hands or from the air.

At the time when I took a decided stand against the indiscriminate

* Read before the New York Surgical Society, January 8, 1919.

employment of rubber gloves (please place emphasis upon my choice of the word "indiscriminate"), I did not wish to be mistaken or to hold to an idea which might be injurious to any of my patients. At that time inquiry was made in reference to this point at various hospitals in which I had occasion to operate. According to the information then received the infections in my own cases were less than in those in the practice of some surgeons who used rubber gloves at all times.

An arrangement was concluded for an expert in tactile sense to make accurate tests of this feature of the situation with several surgeons. The thinnest and best of rubber gloves were employed and the experimenter found that the sense of touch was regularly diminished in all of the men tested, although two of those who wore rubber gloves had developed their sense of touch while wearing gloves almost to a normal degree. One of these men was a surgeon of exceptional skill; the other, a physician not belonging properly among surgeons, but a specialist in children's diseases. At the time when my opposition to the indiscriminate use of rubber gloves was held to be erratic, I was interested in formulating the principles of the Fourth or Physiologic Era in Surgery in which we are to conserve the natural resistance of the patient in every possible way in order that he may better develop his opsonins and phagocytes immediately after the operation. This included among other points the idea of rapid work through comparatively short incisions. The employment of rubber gloves related more particularly to the Third or Pathologic Era in Surgery in which the surgeon was to employ all of his resources for keeping bacteria out of wounds and for destroying those which had entered the wound. Certain principles relating to both the third and fourth eras of surgery need to be harmonized at this stage in the evolution of our subject.

When should rubber gloves be employed? In practically all routine work in almost all departments of surgery. We then elaborate and classify cases in such a way as to ask in which group of cases the employment of rubber gloves should be obligatory; in what class of cases they are unnecessary, and may or may not be used according to the wish of the surgeon, the matter being irrelative to the patient's interest; lastly, in what group of cases the employment of rubber gloves would lessen somewhat the patient's chances for receiving the highest degree of skilled attention.

The employment of rubber gloves should be obligatory in practically all work belonging to general surgery and obstetrics—a field so large that mere reference to the point is all that is required. The group of cases in which rubber gloves may or may not be used would include several quite separate fields of surgery. There are certain areas of the body like the oral and anal regions, for example, which we call protected areas in the sense that they are so constantly exposed to bacterial invasion that nature appears to have established special guards

against the entrance of infection into the tissues. These areas cannot be thoroughly sterilized by any of the methods at our disposal, and primary union is the rule after operation in cases in which incomplete methods of asepsis have been employed by the surgeon; or, if not primary union, a benign tendency toward repair. The perineal region is included in this area, and a surgeon working without gloves may sometimes repair a torn perineum particularly well and speedily when depending upon his best sense of touch. We have come to know that the peritoneum under ordinary circumstances is remarkably resistant against bacterial invasion, and that Tait working without asepsis or antiseptics in his day secured better results than were secured by his rivals advocating the use of asepsis and antiseptics. Tait worked with great rapidity through short incisions, aided by the sense of touch, and conserved the natural resources of his patients. Peritoneal adhesions require for their separation a particularly nice sense of touch and delicate manipulation of viscera. To quote Dr. T. L. Bennett, the expert anæsthetist, "the best surgeon is the surgeon who acts all the while as though he were afraid of waking the patient up." The employment of rubber gloves in peritoneal adhesion work commonly requires a much larger incision and more work by sight than would be required by the skilled surgeon depending upon his sense of touch. In perforating ulcer of the stomach or in typhoid perforations the surgeon working without gloves may insert his drains so quickly that the entire operation may be performed in some cases in less than five minutes—a life-saving step frequently resorted to and followed by better technical surgery later if necessary. The presence of calculi in the common bile duct, in the pancreatic duct, or in the ureter, sometimes requires the last degree of fineness of tactile sense in order to avoid the more extensive surgery which would otherwise be in order. With one finger of the surgeon inserted through the peritoneal abdominal wall, pressing a small ureteral calculus firmly against the muscular abdominal wall, the operator may employ his other hand for approaching the calculus from some external point so rapidly and accurately that the calculus may be removed in a very few minutes of operative work.

In many cases of chronic appendicitis with old adhesions, and in many cases of acute appendicitis with extensive new adhesions, the surgeon's sense of touch may be employed at its very best for avoiding more extensive surgery which would belong to work by sight. This is true also in cases of pelvic infections; and it would appear almost an absurdity for a surgeon to employ rubber gloves with the idea of avoiding infection, in cases where infection is already present to a high degree. Protection of the surgeon is perhaps the only valid argument in favor of the employment of gloves in such cases.

Under modern methods of treatment the pleura is found to be nearly as resistant to infection as is the peritoneum; and one may sometimes

open the chest wall, allowing the lung to collapse, and with the ungloved hand find a missile or enlarged glands or a small lung abscess with a rapidity eminently desirable when we are working without the aid of the pneumatic cabinet.

In cases of malignant disease of almost any part of the body, the malignant disease has called out such a protective force in the surrounding tissues of the patient that primary union often occurs—as in such cases in olden times when the surgeons washed their hands after operations instead of before operations.

In some of the tissues which are not especially protected in any way, one sometimes works to advantage by the sense of touch so rapidly that fewer bacteria are carried in by the hands than would fall in from the air. The operation for loose kidney, for example, may frequently be completed in ten minutes of operative work between the first incision and the last suture. This, however, is a special occasion and would not refer to general application of the principle which includes the employment of rubber gloves.

In the group of cases in which the use of rubber gloves actually lessens the efficiency of the surgeon to a degree detrimental to the interests of the patient, we think at once of certain operations upon the eye and in nose and throat work.

As a final statement I would express the opinion that the employment of rubber gloves in routine work for practically all surgery represents one of the most important advances that has been made in the surgery of to-day. A few situations allow the expert surgeon to do better work without gloves.

In hospital rules making the use of rubber gloves obligatory it may be well to insert a clause to the effect that when a surgeon does not use rubber gloves in any given case he is to make a record of his reasons for the omission.

TRANSACTIONS

OF THE

NEW YORK SURGICAL SOCIETY

Stated Meeting, held November 13, 1918

DR. WILLY MEYER in the Chair

TUBERCULOSIS OF THE SPLEEN

DR. FORBES HAWKES presented a patient who had been previously shown before the New York Surgical Society on October 26, 1910, with tuberculosis of the spleen. He was eight years old at that time and had been operated upon for a large adherent spleen. Sections removed from the spleen had shown tuberculosis. He had made an excellent recovery—the spleen had diminished in size, and the boy had been in perfect health since then. When shown on November 13, 1918, his spleen was not palpable. His operative scar was solid. He had been at work during the period of the war in a tool factory, doing overtime work as well.

DR. WILLY MEYER considered it very interesting that a tuberculosis of the spleen was affected by laparotomy in the same favorable way as are so many cases of tuberculous peritonitis. The young man's good condition after a number of years certainly points in this direction.

BILIARY CIRRHOSIS AND CHRONIC PANCREATITIS

DR. A. O. WHIPPLE presented a woman, sixty years of age, married, who, on admission to Presbyterian Hospital on June 20, 1918, gave the following history: Persistent jaundice; swelling of the abdomen. Dates back one year. Following an indiscretion in diet of rich food, she had an attack of indigestion characterized by severe dull pain in the epigastrium, radiating to the back. The severe pain lasted two days and she noted that her skin and scleræ were becoming jaundiced. Since then she has had recurrent attacks of pain in the same region, radiating to the back, made worse by eating too much and by taking fats or coffee. At times the pain was relieved only by morphine. The jaundice has remained fairly constant, gradually changing from yellow to a bronze color. Stools have been clay colored, though at times they show a slight yellowish tinge. There has been great pruritus. During the past twelve months she has lost over fifty pounds and during the past three months there has been marked loss of strength and appetite.

For many years she had had mild attacks of indigestion with bloated feeling and eructations of gas. No history of typhoid. One pregnancy thirty-eight years ago. Patient was seen three months before operation,

when she came to the hospital for observation and study, where she remained for four days. At that time, which was in April, 1918, she showed a deep bronze color; she was very nervous; pulse was slow; no evidence of hyperthyroidism; the abdomen was flat with a prominence in the right upper quadrant and epigastrium. This corresponded roughly to a mass which extended 4 cm. below the costal margin, moved on inspiration; was slightly tender; surface was smooth. It was considered to be the liver. Wassermann was negative; her blood began to clot at eleven minutes. There was a slight trace of bile in the stool. X-ray examination showed a large oval shadow situated just to the right of and opposite the body of the second and third lumbar vertebræ. This was diagnosed a gall-stone. The diagnosis was made of *chronic cholecystitis, cholelithiasis, with stone in common duct.* Patient decided to defer operation and was observed several times during three months. Her condition did not improve and she lost more weight and developed ascites.

At the time of her second admission, the liver was found 6 cm. below the costal margin, it was tender; patient was deeply bronzed, showed only a slight trace of bile in the stools and her blood began to clot at thirteen minutes. A preliminary infusion (300 c.c.) of a 0.2 per cent. solution of calcium lactate in normal saline was given. Urinalysis did not show at any time glycosuria.

Operation (June 22, 1918).—An ⅃-shaped incision gave good exposure and disclosed the following findings: About two gallons of free fluid were aspirated, bile-tinged in color. The liver was enlarged down to the level of the umbilicus. The surface was smooth, there were no nodules and it had the appearance of a cirrhotic liver of the hypertrophic type. A mass was found on the under surface of the right lobe densely adherent to the stomach and duodenum. This mass was found to consist of the gall-bladder, surrounded by omentum. The tip of the gall-bladder was white and nodular, resembling carcinoma, but a section from the attached omentum and from the wall of the gall-bladder made at the operation by frozen method, failed to show carcinoma. The gall-bladder when opened showed a dense, thick wall and the lumen was occupied by a very large gall-stone, measuring 5 by 3 by 3 cm. There was some pus about this stone and the walls of the gall-bladder were markedly degenerated, in places showing actual calcification. Cystic duct was found to be patent, a clear golden bile coming away after removing the stone. The pancreas was not uniformly enlarged, showed a marked induration about the common duct. Because of the patient's jaundice and the very dense character of the adhesions between the gall-bladder, stomach and duodenum, a cholecystectomy was not attempted, although it was considered the operation of choice. Instead, cholecystostomy was done. Because of the dense adhesions about the common duct and the hemorrhage resulting from attempts to open it,

choledochotomy was not accomplished. Drainage aside from the cholecystostomy tube consisted of a cigarette drain to the bottom of Morrison's pouch. The patient's condition was fairly good—pulse 86 at the close of the operation. There was no tendency whatsoever to hemorrhage, blood clotting firmly in the wound.

Patient showed no marked reaction following operation; distention was easily controlled with colon irrigations; she drained bile freely from 700 to 1000 c.c. every day. The tube was left in place for twelve days, when it was extruded. After that, biliary fistula continued throughout the patient's stay in the hospital of thirty-seven days. Stools remained acholic during this time. The patient showed a loss of appetite and considerable asthenia during the last two weeks of her stay in the hospital. By means of tonic treatment and the administration of pancreatic extract and ox-gall, she was able to digest her food fairly well. After leaving the hospital, she continued to have a fistula with clay-colored stools for ten days, that is, for about seven weeks after operation. She then noted that the discharge from the fistula suddenly ceased and she began to have colored normal movements. Fistula has remained closed and the patient has continued to show marked improvement. Examination two months after operation showed an abdomen normal in contour, firm, linear scar, the liver edge had receded to within 2 cm. of the costal margin, there was no fluid and no masses nor tenderness.

Patient when examined six months after operation shows good color, no jaundice in skin or scleræ. Scar linear, firm. No fistula. She has gained twenty-five pounds in weight since operation.

Dr. Alfred S. Taylor said that when a patient had suffered the drainage of bile outside the body for a long period he became thin and weak. He had had that experience with a case this summer after long drainage of bile. Dr. John Gerster had had a simliar case where he followed the method of taking the drained bile and putting it back into the patient's stomach. He suggested the application of this method to Dr. Taylor's patient. Her own bile could not be used satisfactorily because of the presence of mixed infection; so clear bile was obtained from another patient and from half a pint to a pint per day was administered through a stomach tube. After a short time she preferred to drink the bile rather than have the stomach tube passed. Almost from the start there was a marked change in the condition of the patient; she improved in strength and developed an appetite, and was able to take food with comfort that she had not been able to retain for a considerable period previously. Under this treatment she progressed steadily, and finally was able to leave the hospital in good condition.

Dr. Willy Meyer stated that in a case of biliary trouble, under his care in the course of last winter, following cholecystectomy there was prolonged bile drainage. About ten weeks later a secondary operation for the biliary fistula was done. Inasmuch as there had not been the slight-

est jaundice, it did not seem necessary to make a coagulation test. But from six to seven days after the operation the patient began to bleed; there was considerable parenchymatous oozing. Blood transfusion succeeded in stopping the hemorrhage.

Doctor Meyer stated that he had no experience in these cases with calcium lactate; he treated patients with chronic jaundice and delayed coagulation for years with preliminary injections of human blood serum in large amounts, within two or three days before operation, and had yet to see a case thus treated that had begun to bleed. So far he had considered this the only safe method at our disposal. It is most interesting to know that there is a second one available. He would like to know whether Doctor Whipple had treated any other than patients suffering from biliary trouble with this injection.

The patient just referred to developed a duodenal fistula about twelve days after the operation. Further surgical work was out of the question. By allowing an extra long duodenal tube to slip down into the upper part of the jejunum as far as possible and keeping the patient's mouth absolutely dry, but feeding him regularly through this tube, the fistula closed spontaneously. This tube was also used for reintroducing into the jejunum the bile which ran out from the fistula in large volume. This also changed the patient's general condition very much. Later on she learned to put the bile into her stomach. It certainly is very desirable not to have the patient lose the bile.

To him it appeared very wise on the part of Doctor Whipple to have made frozen sections of the gall-bladder fundus during the operation. The result of the immediate examination in this case enabled him to retain the gall-bladder for prolonged drainage. With the gall-bladder in place we can arrange for drainage just as long as desired. The time of directly draining the bile-ducts is more limited. Yet, only prolonged drainage can cure these cases.

Doctor Whipple stated that he failed to mention the fact that the patient's blood was tested the morning before the operation and the clotting time was seven minutes. The reason why he was using calcium lactate intravenously for preventing hemorrhage was because of the experience he had had with a patient whom he had presented at the Society last spring. This man had very much the same lesion that the patient whom he presented this evening showed. His clotting time before the operation was thirteen minutes. He was given a preliminary transfusion of Group 2 blood from a member of the interne staff. He stood the operation very well, but six days later began to bleed from the wound. Notwithstanding a second transfusion and administration of bile by mouth he continued to bleed and his condition became very critical. In desperation it was decided to try calcium lactate by the blood stream, with the idea of introducing calcium more directly into the patient's tissues.

The intravenous dose was found to be 5-10 grains, given as a 0.2 per cent. solution in normal salt solution. This is the dose given by Bastedo in his " Pharmacology." The effect of the medication was very graphically demonstrated, for the infusion was given while the wound was dressed and the wound which at the beginning of the dressing showed no blood coagulation whatsoever, in twelve minutes showed a firm clot in the wound with complete stoppage of the oozing.

Since that experience the calcium lactate infusion has been tried in eight cases of deep jaundice. In every case the clotting time has been reduced by one-half or more.

In regard to the complication that Doctor Taylor mentioned: Several such cases have been observed at the Presbyterian Hospital. In these cases the administration of bile, preferably the patient's own, either by mouth or by gavage, has improved the digestion of the patients in a remarkable manner. This asthenia and loss of weight is a very serious problem in a patient who has been chronically ill for weeks and has undergone a severe operation.

In closing Doctor Whipple said that the severe oozing under discussion was not dependent upon bile in the tissues, but rather to an absence of bile salts in the alimentary tract, for the same bleeding may occur in a patient with a biliary fistula without a trace of jaundice, in fact, the oozing may be more persistent in such a case than in the deeply jaundiced.

NON-PARASITIC CYSTS OF THE SPLEEN.

Dr. Adrian V. S. Lambert read a paper with the above title, for which see p. 15.

EDITORIAL COMMENT

JANSSEN ON CRANIOPLASTY: ITS INDICATIONS AND ITS TECHNIC

In the second volume of " Travaux Scientifiques," from the Ambulance de l'Océan at La Panne, Belgium, Dr. Charles Janssen discusses the indications and technic of cranioplasty. He says: Brain wounds healed after operation are not guaranteed against later complications. Much has been said about the late reappearance of a cerebral infection which had apparently been overcome. Recent studies seem to show that the frequency of such late infective complications have been greatly exaggerated. In addition to the fact that our primary interventions each day have become more precise and more radical, the useful and indispensable control which the laboratory and neurological examination brings to us, awakens the hope that in the future these accidents will diminish still more. Tuffier in his report has noted in 6664 cases of cranial wounds observed 122 late accidents; that is to say, 94 cases of abscess of the brain (1.41 per cent.), and 32 cases of meningitis (0.40 per cent.). The late mortality attending this series was 1.24 per cent.

But aside from infection there exist other complications to be feared as attendants upon old wounds of the cranium and of the brain. Minor accidents are met with in the great majority of those who have been trephined. Further, such grave troubles as epilepsy, partial or general, are frequent. Tuffier found them 676 times out of his 6664 cases; that is to say, 10.14 per cent. Our personal inquiry still incomplete gives us almost an identical figure, 10.9 per cent.

What are the causes of these non-infectious post-traumatic accidents? A prolonged study will be required to make us positive, but already some facts have appeared on the way and useful therapeutic deductions may be made.

I. *On the Repair of the Losses of the Cranio-Encephalic Substance.*—If we take up for consideration behavior of the bony substance after trephining, we note the rarity of osseous regeneration. Practically when a loss of substance has been left to itself repair of osseous tissue never takes place.

The cranial bones are covered on their external face by a periosteum similar to that of other bones. Their internal surface is in intimate contact with the dura mater. Can this be considered as performing the office of an internal periosteum? As long ago as 1837, Dubreuil concluded from his experiments that the repair of loss of substance of the cranium was furnished by the periosteum and the dura mater. Ollier in 1859 demonstrated the osteogenetic properties of the dura mater. It is well known also that a bone of the cranium destroyed by a slow pathological necrotic process, as in

syphilis, may regenerate itself more or less completely, but in such a state there is the reactivation to osteogenetic property in consequence of chronic irritation. Nevertheless, notwithstanding the real osteogenetic power of these periosteal membranes, the bones remain after a large trephining in the state in which the surgeon left them. Sometimes, even, there may be observed after a long time enlargement of the breach in the cranium. Some authors have thought that they noted that, if the wound remains a long time open, the loss of bony substance tends to diminish. Perhaps we shall find in this fact a suggestion as to the cause of the absence of bony regeneration in the bones of the cranium. In fact, if the wound remains a long time open, the external periosteum and the dura mater coalesce very slowly. During the whole period in which the dura mater, the periosteum and the osseous cut surface remain uninfluenced by the process of cicatrization, the bone may possibly regenerate itself. It will be then by the occlusion of the surface of the fracture, by the fusion of the periosteum and the dura mater to which may be attributed the absence of regeneration. Growth of the borders of bony substance thus encapsulated by the periosteal-dural cicatrix can no longer occur. This union of the dura mater and of the periosteum presents also other inconveniences.

How is cicatrization of the substance of the brain and its envelopes accomplished? In a work which appeared in June, 1916, Bériel studies the cicatrization of open wounds of the brain. He observes the hyperplasia common to the tissues, dura mater, soft meninges, brain. In the meninges this hyperplasia induces a homogeneous increase of the tissue and constitutes a phenomenon of fortunate defense since it hinders the diffusion of infection. But as regards the cerebral tissue, it results in an increase in the connective tissue framework, a sclerosis of the neuroglia. Bériel believes that this junction, so useful as a barrier against infection, disappears after a time, and that progressively an isolation of the dura mater is produced. Liberation of the latter would be due to the movements of the brain which favor the redevelopment of the subarachnoid spaces.

The examination of microscopical preparations has not demonstrated to us such return of normal anatomical conditions. On the contrary, we have observed in the new formed epidermis a thick connective tissue layer, then in contact with this homogeneous layer a mixed layer where are mingled the elements of connective tissue with nervous elements derived from the neuroglia. The adhesions are very close and we have not been able to observe the cleavage noted by Bériel which seems to us more easily explained by a pathological process, a cystic formation, than by a return of the normal state. There remain then the following lesions:

1. In the brain a proliferation of the type of neuroglia.

2. At the level of the meninges a growing together resulting in fibrillous connective-tissue thickening, uniting on one side the brain to the hyperplastic meninges and on the other to the periosteum or to the connective tissue of the cutaneous cicatrix. There results from this a fixation of the

brain, a union at the circumference of the osseous breach and of the soft epicranial tissues. It is logical to admit that this process of sclerosis changes considerably the functional equilibrium of the brain. Its vascularization, the motility, the intimate function of the cerebral substance would be expected to be very profoundly modified.

II. *Non-Infectious Accidents Consecutive to Cranio-Encephalic Traumatism.*—From this category should be stricken out every accident which could have originated in an infection imperfectly overcome or recurring; symptoms also which are caused by destructive lesions of this or that center are not considered, such as hemiplegia, monoplegia, apraxia, astereognosis, hemianopsia, etc.; though, indeed, these sometimes are not the result of an anatomical destruction of corresponding centers, but come from functional interruption due to lesions of the neighborhood, compression, hemorrhage, etc. But such accidents are only temporary. Besides the disorders attributable to localized lesions of the encephalon, there are others much more frequent whose origins are less positively recognizable. Such accidents as headache, vertigo, psychical troubles, insomnia, emotional disturbances, varying much in their intensity, are observed in many cases. Pierre Marie has met them 98 times out of 323 old trephined cases.

Sometimes the subjective symptoms coincide with an objective element, such as changes in the cerebrospinal fluid, hypertension, sometimes lymphocytosis, but in such cases it is more likely that there is involved an old imperfectly extinguished inflammatory process or a meningeal infection in process of development. From what we know of the suddenness of the explosions of symptoms in cases of abscess of the brain in men who have for a long time already carried an intracerebral suppurating focus, we are led to the conclusion that important changes in the cerebrospinal fluid are connected with an infection.

Finally, the most frequent and most to be feared accident is epilepsy. Sometimes localized symptoms, generalized symptoms, severe even to the point of the production of extreme convulsive crises and even rapidly involving death, sometimes, on the other hand, slightly betraying itself only in slight symptoms, such as mental confusion and visual dazzlings.

Thus, the following situation is presented: On one side, accidents going even to grave epileptiform crises; on the other side an anatomical lesion consisting only in adhesions. It seems to us logical in the present state of our knowledge to adopt a treatment which should have for its object a suppression of this anatomical lesion and to hinder its production.

III. *Indications for Cranioplasty.*—To cure and above all to prevent important accidents which are so frequently the sequelæ of craniocephalic traumatisms, we possess in cranioplasty, preceded by encephalolysis, an efficient remedy.

The indications for cranioplasty are three kinds:

1. The restoration of external symmetry. Every loss of substance situated in the frontal or fronto-temporal region; every poorly healed cicatrix;

every loss of substance accompanied with marked depression comes under this category.

2. Prophylactic indications. To this class belong the following: (a) All cranio-encephalic lesions involving a loss of meningeal substance; (b) every cranio-encephalic wound which has healed by granulation; (c) every loss of substance of a dimension 3 cm. in diameter; (d) every loss of substance covered with thin and fragile connective tissue.

IV. *Curative Indications.*—Under this heading come: (a) Such accidents as headache, vertigo, etc., if they are troublesome by their intensity or by their frequency, when the infectious cause of these accidents can be certainly ascertained.

(b) Accessory accidents, grave or frequent, which are not caused by the existence of an intracerebral body or by a hæmatoma.

Contraindications.—Certain contraindications should be considered, such as:

1. The accident of the loss of substance; a relative contraindication which can be overcome by the adoption of some alloplastic proceeding.

2. The vicinity of the ventricles feared by some; but is not to be accepted as an absolute contraindication.

3. Permanent hypertension which does not give way to repeated lumbar puncture.

4. Every imbedded projectile which cannot be extracted, especially if it is not well borne.

5. Every syndrome which suggests the existence of a latent meningeal or encephalic infection.

6. The presence of splinters which cannot be extracted at the time of operation.

Most authors recommend that several months should elapse after the wound before intervention, but we do not share in this view. What these authors fear is that the intervention may reawaken an imperfectly extinguished infection. To-day, however, our patients when operated upon recover, as a rule, without infective complications. If, however, one has to do with a case which has undergone prolonged suppuration, or a case which has been complicated with abscess of the brain, one should wait many months and not intervene as long as there exist any symptoms of infection. As to this, systematically practiced lumbar puncture, as well as radiography, will furnish important information. The complete neurological examination and inspection of the fundus of the eye are equally indispensable before proceeding to operate.

With these reservations, early cranioplasty presents the great advantage of preventing accidents always to be feared after a cranio-encephalic wound.

The question of the date of the cranioplasty may therefore become an affair of convenience. Given a patient who has always been free from fever, in whom healing by first intention has taken place, who presents no symptom suggesting infection, one can practice the restorative operation as soon as

the state of the soft tissues permits of it, possibly a month after the wound.

Experience has demonstrated that the results in such cases are always favorable. In other cases one may wait; sometimes even operation must be refrained from altogether. We have done cranioplasty as early as twenty-four hours after the wound; the result was perfect, but as a matter of principle, we do not advise this manner of proceeding. It appears to us to be applicable without danger only in cases of simple cranio-encephalic wound in which the dura mater has not been opened, a case in which there is no important interest in supplying so early the loss of substance.

V. *Operative Technic.*—Operative technic should have as its chief aim to do a prophylactic or curative procedure, æsthetic and protective ideas being secondary. The objects are, therefore:

1. To remove the adhesions between the tissues of skin, cranium and meninges, and the meningo-encephalic substance.

2. To prevent the redevelopment of such adhesions.

3. To remedy the cranial defect which exposes the patient to danger in case of new traumatism.

4. The reëstablishment, as far as possible, of the external shape of the cranium.

For the closure of the breach in the cranium one may possibly avail himself of: An osteoperiosteal flap from the cranium which may be turned down or slid over, so as to serve as a cover for the opening in the cranium. Free bone grafts are, however, more frequently to be employed, displacing inorganic materials which have formerly been relied upon. The method of free grafts dates from the experiments of Ollier in 1865. Such grafts are taken most frequently from the anterior face of the tibia. This source of plastic supply has been adopted by the author in his work. The reformation of the cranial skeleton is not the only thing which is to be considered. The removal of extensive adhesions and the repair of the dura mater are important operative indications. The graft reconstituting the meninges is as important as the cranioplasty properly so-called.

In 1893 Sacchi demonstrated that if in reimplanting the trephined button the periosteal surface was put toward the brain, one could prevent the formation of adhesions, even if there existed a loss of substance of the dura or of the cerebrum underneath. These facts have been confirmed by many authors and have influenced the present writer in the method which he himself has adopted. By a graft from the fascia lata one may cover over a large loss of substance of meninges.

Finally, a graft of fat tissue has been utilized to fill in a cavity resulting from a loss of brain substance.

Cartilaginous grafts have given in the hands of some very good results; but cartilage, well tolerated at the beginning, undergoes later absorption. The bone graft is the process of choice provided the grafts obtained retain their periosteum and are of slight thickness. Microscopical preparations

show that such a graft becomes the seat of two kinds of phenomena, resorption and regeneration.

In the performance of this procedure the most scrupulous attention must be given to the removal of meningeal adhesions and the prevention of their return. The trephine orifice should be fully exposed. In many cases enlargement will be necessary. Thus there is brought to view the area of adhesions or of the most pronounced sclerosis. It is necessary, then, with scissors and with bistoury to excise freely all tissue which is plainly cicatricial. This may sometimes carry one afar. One hardly knows how to fix a limit to this excision. Each individual operator must be guided by the gravity of the case as to how far his bistoury should go. After the excision has been made, one finds himself confronted by the loss of meningeal substance and sometimes of brain matter. For the repair of the meningeal substance, a fascia lata graft is the best method, the one whose results are most to be depended upon. Some points of suture with fine catgut fix the graft to the meninges. If the depression is very deep, hindering the osseous graft, it is well to have recourse to a fat graft. One may fearlessly place an adipose cushion in contact with the brain, but experience has shown that it is necessary to avoid grafting at one time too much fat. In fact, in such a case there may be induced a partial necrosis of the graft at its central portion, while the periphery attaches itself perfectly. Upon microscopical examination one sees these two zones, one where the cells are normal, and one where the clusters of adipose cells have disappeared, where one meets with fatty cysts.

The principal ends to which the surgeon should direct his efforts in putting the graft in place are to make the fixation sure; to put it in so that it may merge itself easily with surrounding tissues so that there may be hindered the formation of adhesions between it and the brain. It is not necessary to resort to points of catgut suture. The periosteum well raised up will permit the graft to be insinuated between it and the external table and will insure a sufficient fixation which will be further completed by the suture of the skin and epicranial tissues.

In placing in the graft, it is greatly to be preferred to turn its periosteal face toward the brain. Thereby will be reduced to the minimum the adhesions between the brain and the neighboring tissues, although the possibility of hyperostosis may render one careful. What appears most important is the fact that an osseous lamella insufficiently united to its periosteum, if it is thrown off, may readily be eliminated as a foreign body. If the osseous surface is turned toward the pericranium, a small incision may remove such a thorn. On the contrary, if it is under the graft, it cannot be removed and it is readily understood that it may determine accidents.

We have never had recourse to any drainage whatever; if the primary dressing is well done and no hæmatoma is formed, one has no need of it.

VI. *Wound Healing and Results.*—The wound healing is simple. Sometimes there develops slight œdema of the region—not enough to cause any

anxiety. The graft at the end of the first week has become adherent to the neighboring tissues. It is practically solid. The immediate result is, then, perfect.

The amelioration of the subjective symptoms is constant, but one should be conservative as to his final results. The operation has an important influence upon the morale of the patients. There is always a disappearance of the fear which such men felt from the knowledge that they were insufficiently protected against external violence.

Up to the present time we have been quite reserved as to the final results to be expected, as far as it concerns the amelioration of the objectives trouble, and particularly epilepsy. Commonly after the intervention there is a temporary improvement, but this by no means indicates permanent amelioration or cure. As to such results the elapse of time must be awaited. But up to the present in the presence of accidents that are serious and which under treatment can be ameliorated, we have an operation simple and not dangerous for which logically one can hope success, so that the author does not hesitate to recommend routine recourse in such cases to free cranioplasty.

HARDE ON THE FREQUENCY OF TETANUS BACILLI AND OF OTHER ANAËROBIC MICROÖRGANISMS UPON THE SURFACE OF FRAGMENTS OF PROJECTILES WHICH HAVE BEEN EXTRACTED FROM WOUNDS *

At the beginning of the war tetanus was a complication quite frequent in wounds in consequence of the lack of antitetanic serum. Thanks to later systematic employment of preventive injections of this serum in all cases of wounds, the early tetanus, which appeared in the course of the first two weeks after the wound, has become very rare. There have remained, however, cases of delayed tetanus developing some weeks, or often some months, after the wound. The appearance of this late tetanus has often followed after a secondary surgical intervention. In the study of these cases of delayed tetanus, two factors have to be considered:

1. It is well established that the spores of the tetanus bacillus can remain a long time latent in a wound without provoking any symptom. Under the influence of a traumatism such spores may undergo development and tetanus break forth.

2. There is a second possibility—namely, that of contamination of the wounds in the hospital in the course of such intervention or of dressings.

When preventive injections of antitetanic serum have been made, a condition is produced wherein the wound may be soiled with tetanic bacilli and yet the man be protected by the injection of the antitetanic serum. The wound may give no indications of the presence of the bacillus of Nicolaier. Later, if adequate asepsis is not observed in all wounds, even those presenting the most reassuring aspect, there remains a risk of hospital contamination.

The literature shows that certain hospitals have a much larger percentage of late tetanus than others. Possibly these hospitals receive their patients from regions particularly subject to tetanus infection; but that may not be the only explanation.

In the course of former researches I have met with two cases in which the wounds contained the bacilli of Nicolaier, without any clinical manifestation of tetanus. One was a case of gas gangrene affecting a large wound of the thigh and of the knee; the patient died on the tenth day. In the other there was a penetrating gunshot wound of the thigh. The bacteriological examination had demonstrated the presence among other microörganisms of septic vibrio and the bacillus of tetanus. The wound became rapidly clean and no complications followed.

In consequence of these observations I have been stimulated to seek for the bacillus of Nicolaier in the wounds of patients who were not tetanic. In such a research one should remember that the bacilli of tetanus are often difficult to identify in a wound, even where tetanus is present. These germs

* Memoir by M. le Docteur E. S. Harde in the "Report of the Ambulance de l'Océan," at La Panne, Tome II, Fasciculus 1, p. 185.

are rarely abundant, they are difficult to cultivate, and in making an experiment one does not always obtain all of the flora of a wound.

A negative result, then, does not demonstrate absolutely the absence of an organism. Further, one must not lose sight of the fact that neither the identical form nor the cultural characteristics are sufficient to affirm at a given time the presence of the bacillus of Nicolaier. There is only one sure criterion—that is, the formation of a toxin which gives the classical symptoms of tetanus in animals in which the suspected bacillus has been injected. One does not admit the existence of non-virulent strains of pseudotetanic bacilli.

With these reservations I present my experiments at Paris in the service of M. le docteur Shutro, at the hospital Buffon. I have studied a consecutive series of thirty non-tetanic cases. The wounds studied date from some days to several months; all, after opening up, have been treated by the method of Carrel-Dakin. The microörganism of tetanus had not been found in any of these cases.

The method followed consisted in obtaining a specimen of wound exudate, a part of which was made use of to soil a splinter which was inserted into the muscles of the foot of a white mouse, an animal very sensitive to tetanus. This is a method of choice to prove the presence of a small number of the spores or of the bacilli of tetanus. A second portion of the exudate was employed for incubation in a medium very favorable for the multiplication of the bacillus of tetanus.

The exudate was implanted in tubes of gelatinized bouillon containing a fragment of muscle of beef or veal, the whole sterilized in an autoclave. These tubes of meat gelatine impregnated with the exudate were placed in the incubator at 37° C. The gelatine became liquefied, and the conditions favored a vigorous growth of anaërobic microörganisms, including the bacillus of tetanus. When microscopical examination of the cultures has seemed to indicate the presence of the bacillus of Nicolaier, these cultures have been inoculated by the intramuscular method into the white mice. By neither of these two methods was I able to demonstrate in the thirty cases examined at Paris the presence of the bacillus of tetanus.

With these negative results it seemed to me important to search for the tetanus bacillus on the surface of the fragments of projectiles extracted from wounds. The opportunity to make this study was given me by Professor Depage at the Ambulance de l'Océan at La Panne.

Sixty fragments extracted from wounds during the months of June and July, 1917, were subjected to examination, an examination which had for its object not only the search for the bacillus of tetanus but also the presence or absence of any anaërobic flora.

By cultivating the fragments together sometimes with pieces of clothing or parts of tissue remaining from the opening up of the wound, there was a greater chance of finding again the complete flora which soiled the wounds at the beginning than when one sowed for cultivation only the exudate; but neither one nor the other of these examinations could be considered as giving

an absolutely certain result. For example, in a case of late tetanus, not included in the present communication, with the late extraction of a shell fragment, neither the culture of the microörganisms of the fragment, nor the cultures obtained by impregnation in various media of exudate taken upon the day following, in different places of the wound, have given the germs of Nicolaier. Out of sixty examinations made, I have obtained a culture of tetanus bacillus only once. These fragments were extracted from half an hour to twenty hours after the wound, except in case No. 2.

The technic of procedure has been as follows: In the operating room the material to be examined has been placed in a sterile receptacle, then inoculated into the tubes of meat gelatine and then incubated at 37° C. for at least seven days.

I have taken care to examine the tubes several times during this period. In cases where the microscopical examination has shown the presence of microörganisms resembling morphologically the bacillus of tetanus, the cultures have been inoculated into white mice. Once only the culture has shown the bacillus of tetanus (Case No. 21). The patient presented five shell-fragment wounds and was operated upon five hours after having been wounded. There were present wounds of the soft parts only, without any fractures of bone. These wounds healed rapidly without complications. They were situated on the forehead, on the arm, on the thigh, on the ankle and at the great toe. The culture of the forehead did not give any anaërobics; all the others furnished them. The wound of the arm showed bacilli of the saccharolytic group, perfringens type. In the wounds of the thigh, of the great toe and of the ankle I was able to detect several kinds of anaërobic bacteria, and among them forms resembling the bacillus of tetanus. Nevertheless, only the culture from the fragment extracted from the ankle developed tetanus after injection in mice and guinea pigs. The other wounds gave only non-virulent cultures of pseudotetanus bacilli. All the wounds after having been opened up healed without complication. The wounds of the forehead, of the ankle and of the great toe were very slight, and in them, after the opening up, reunion was obtained in a few days.

The wounds of the thigh and of the arm, after having been opened up, were treated by the Carrel-Dakin method and sutured on the fifth day, with likewise reunion per primam. The patient had received the usual prophylactic injection of antitetanic serum, which was not repeated.

In seven cases out of the sixty there were found bacilli resembling morphologically the bacillus of tetanus, but being without virulence. These bacilli should be considered as pseudotetanic.

Fifty-two times (*i.e.*, 86.67 per cent.) there existed anaërobic bacteria which, according to the classification of Henry, were not only members of the saccharolytic group, including the perfringens bacillus, but very frequently also bacilli of the proteolytic group, including the bacillus sporogenes, etc.

There were also frequently associated with these streptococci and other

aërobic bacilli; but in no case of our series was there gas gangrene. I have rarely observed grave generalized infection, notwithstanding the frequency with which the surface of the fragment was strongly infected. This demonstrates once more the fact, already well established, that surgical intervention practised as early as possible in a wound and with a free opening up overcomes effectively the chief infection of gunshot wounds.

The results of these examinations relative to the presence of bacilli of Nicolaier should be compared with the statistics of cases of tetanus observed in the Ambulance de l'Océan at La Panne, and in the English army at the beginning of the war, when the employment of antitetanic serum had not yet become so common as it is to-day at the Ambulance de l'Océan. Doctor Govaerts has published the statistics of the first 800 patients brought to the hospital. In these, six cases of tetanus occurred; that is to say, 7.5 per mille. For the English army Bruce has published that in September, 1914, tetanus occurred in 16 per mille of the wounded. It would result from the present study that the bacillus of tetanus is met with in one out of sixty; that is to say, 16.6 per mille. All these figures are comparative. It is true that this figure increased in October, 1914, for the English wounded, to 32 per mille; but the English troops were at that time fighting in a region recognized as especially infected with tetanus, which was not the case in the wounded subjected to our own observations.

En résumé, the result of the examination of sixty foreign bodies, fifty-eight fragments of projectiles and two rifle balls, taken from wounds, was, first, that the bacillus of tetanus has been found once in sixty cases, or 1.66 per cent.; that anaërobic germs of many kinds, the bacillus perfringens and others often associated with streptococci, have been observed in fifty-two specimens, that is to say, in 86.69 per cent. of the cases, without any of these patients having later presented complications of gaseous gangrene or of grave infection due to anaërobic bacilli.

TREATMENT OF CHRONIC OSTEOMYELITIS OF TRAUMATIC ORIGIN*

At the Interallied Conference for the Study of War Wounds, held in Paris in November, 1917, the *Treatment of Chronic Osteomyelitis* was the subject of a communication by M. Jacob, of Belgium. The reporter prefaced his paper by calling attention to the gravity of the complication of chronic osteomyelitis in injuries of the bones from war projectiles. By repeated acute attacks it diminishes very greatly the working ability of all wounded men and exposes them to all the dangers of chronic infection. Through atrophic changes in the muscles, vessels and nerves that it produces in the part of the limb attacked, by the phenomena of chronic arthritis that it develops in neighboring articulations, it always entails a loss of function and sometimes accidents which demand amputation.

It is tenacious in its course, and its final cure is always difficult, sometimes impossible to secure. It is a frequent affection. Up to October 1, 1916, out of 12,201 wounded men brought to the base hospitals, there were 2682 patients who presented osteitic fistulæ which had been more than a year under treatment. At the same date fistulous osteitis alone represented from 80 to 90 per cent. of the entries into certain surgical services. At the time the Jacob report was made its frequency had much diminished, so that it was producing not more than 20 to 25 per cent. of hospital entries. The cause of this diminution was attributed to active and early surgical treatment directed against infection.

Chronic osteomyelitis may develop after a simple contusion of the bone, as after a fracture; it occurs also as one of the consequences of amputations; but the most frequent form, one much the more interesting from the point of view of treatment, is the osteomyelitis consecutive to open fractures, and this is the only form which the reporter proposes to consider in his paper.

Consecutive to an acute osteomyelitis a chronic form develops according as the area of fracture has been more or less judiciously and early treated. It is naturally favored by the presence of intraosseous foreign bodies and transosseous drainage. The view that an osteomyelitic cavity possesses the form of a transosseous tunnel possesses a certain importance from the standpoint of the operative treatment of osteitic fistula.

The bones most frequently attacked by osteomyelitis, as observed in the author's service at Val de Grâce, based upon his observations of 182 cases, are, approximately: the tibia, 22½ per cent.; femur, 20 per cent.; humerus, 17½ per cent.; clavicle, 10½ per cent.; bones of the forearm, 10½ per cent.; pelvis, 7½ per cent.; bones of the feet, 5½ per cent.; the spine, 4 per cent.; bones of the hand, 2 per cent.

The proper prophylactic treatment for the prevention of chronic

* *Comptes-Rendus de la Conference Interalliée pour l'étude des plaies de guerre*, 3d session, 5–8 Novembre, 1917.

osteomyelitis is simply the early, adequate surgical treatment of fractures, viz.: a free exposure of the seat of fracture in the first hours which follow the injury; the removal of foreign bodies and of débris of clothing; excision of the track of the projectile through the soft parts, the removal of free bony fragments and the subperiosteal resection of bony fragments still adherent, but contaminated by septic foreign bodies; finally, immediate closure of the wound, or, if this is impossible, secondary closure after progressive sterilization under bacteriological control of the infected area. This treatment, applied extensively during the past months in the various sanitary units at the front, has given excellent results, and to it may be attributed the great diminution in the number of cases of osteitic fistulæ now under treatment in the base hospitals.

When, however, chronic osteomyelitis has developed, what is to be done? It cannot be too strongly emphasized that osteomyelitis is controllable only by an operative interference which involves the free exposure of the osteitic focus throughout its whole extent, in the complete removal of the lesions; finally, in the securing of the cicatrization after the bone cavity has been rendered shallow and fully open. The sooner this is done, the better; that is to say, the procedure should be resorted to as soon as the diagnosis is established.

From the point of view of diagnosis, the radiograph may furnish valuable information, much more important than that given by simple exploration with a probe, and every patient who is the subject of an osseous fistula should be subjected to X-ray examination. The X-rays may, moreover, reveal an unexpected projectile, or one which has not been extracted. In osteitis of the diaphysis they show the form and the limits of the bony callus and render visible the inflammatory cavity of the osteitis, its extent and the sequestra which are contained in it. All such sequestra are not necessarily in the area of the fracture. They are found often at a certain distance from this area along the track of fissures which earlier communicated with the fracture and which the reparative process has more or less covered up. One should not be content, therefore, with a single radiograph, but multiple radiographs should be made from different aspects of the bone, so as to reconstitute the type of the fracture and the track of fissures. Thus the operator may obtain important indications as to the diagnosis and the localization of sequestra, furnishing a valuable guide for their removal.

Again, in osteitis of the epiphysis the X-rays may make manifest the foyer of softening and the extent, sometimes considerable, of the decalcified zone about it.

Jacob is in the habit of having radiographs made after there has been placed in the fistula, or in each of the fistulæ when several exist, a piece of silver wire whose extremity has been blunted by ignition in an alcohol lamp. By this means the plate shows the fistulous track marked by the metallic thread and sometimes even the sequestrum down to which it

passes. Injections of the fistula with bismuth paste (Beck) may also be used to give a clear image of the fistulous cavity and its diverticula.

At the time of the operation the incision through the soft parts down to the bone should, as a general rule, be parallel to the long axis of the limb and should pass through the fistula; but should the fistula be seated in a position unfavorable or dangerous, one should disregard it and select the proper anatomical path for access to the region. Whatever its seat, the incision should always be long, for the induration of the soft parts renders their retraction difficult. Sometimes it may be even necessary to make a transverse accessory incision. When the bone has been exposed, the periosteum should be pushed back by the elevator throughout the whole extent necessary to give free access to the parts diseased. If there is present a transosseous tunnel consecutive to a perforation of the bone, or to the prolonged presence of a transosseous drain, this tunnel must be transformed into a trench by cutting away the most superficial portion of its walls. If an intraosseous cavity is present, it is necessary, by scissors or gouge, to penetrate to the bottom of the lesion by enlarging the fistula, or by creating a path of access to it through the excessive callus.

In osteomyelitis of the diaphysis this work is often difficult, for the osseous tissue is sometimes as hard as ivory. One is thus conducted into one or more irregular cavities, where one finds imbedded in fungosities and pus one or more sequestra. These sequestra are sometimes long, voluminous, and it is necessary to open throughout its whole extent the cavity which contains them in order to easily extract them. The sequestra-containing cavity should then be carefully curetted; the least diverticulum, the smallest recess, should be widely opened up.

In osteomyelitis of the epiphysis the lesions met with are quite different. The gouge, the scissors, the curet, penetrate spongy tissue, soft, friable, fungous in places. The sequestra are almost always small, like nuclei in the fungosities, and the cavities which contain them have indistinct walls. These conditions remind one of tuberculous caries. Here, again, it is necessary to take away everything which is diseased. All the softened tissue is curetted away until one arrives at a layer of resisting bone, which represents the zone of defense of osseous tissue.

In certain regions, particularly those of the great trochanter, and certain of the flat bones, such as the iliac bone and the scapula, the osteomyelitic process is often accompanied with proliferating spongy tissue, so that there is produced a real tumor, prolonging itself in an irregular manner between the neighboring muscles, a tumor which it is necessary to completely resect.

Whatever the form of the osteomyelitis which is being dealt with, the surgeon must not lay down his gouge, his scissors, his curet, until he has everywhere reached healthy tissue. He must not even hesitate, in cases, rare indeed, where the lesions have involved the whole thickness of the diaphysis, to break the continuity of the bony lever; that is to say,

to make an osteotomy and to practise a subperiosteal resection of the segment of the diaphysis involved. Another indication for such an osteotomy may be found in a very marked deviation of the axis of the limb due to vicious consolidation of the fracture. It is sufficient at the close of the operation to put the limb in extension.

Any operation directed for the cure of chronic osteomyelitis is a procedure always long and difficult, sometimes serious in character. Good assistance is necessary, and excellent lighting. It is necessary, in fact, at every stroke of the gouge or of the curet, to see well what has been done; otherwise, one risks leaving unattacked a doubtful point, a small fungous recess, a small fistulous track which may become the beginning of a recurrence. It is always useful, often indispensable, to employ the artificial lighting furnished by a mirror.

All the diseased portions having been removed, the operation is not finished. There remains a cavity, a deep trench, which it is necessary to make as shallow as possible by cutting away its borders so that cicatrization can be induced. In this work of converting into a plane surface the deep groove, one must watch out not to diminish too much the strength of the bone, except in those cases where the extent of the lesion demands a true resection of the diaphysis. The operative wound should be left widely open without suture.

Post-operative Treatment.—Dressing should be done with great care, watching constantly that the wound of the soft parts is not closed before the cavity itself is filled in. At every dressing the walls of the cavity should be examined carefully to detect any doubtful points. A stroke of the curet made at the proper time may stop at once a recurring process of osteitis.

The author utilizes the interval irrigations with the Dakin fluid after the method of Carrel in the after-treatment. Ordinarily, about the thirtieth day he finds that the microbic count has then become so infinitesimal that secondary suture can be attempted with success. Attempts to hasten the cicatrization of deep cavities by filling them with a solidifiable mixture, or with a graft of adipose or muscular tissue, have not been followed by encouraging results. In a large number of cases in which such attempts have been made, the plastic mixture or the grafts have been thrown off. This is not to be wondered at, if one recalls that the microbic flora remain very abundant in the first days following intervention. So, also, any attempts made after several months' treatment have often failed. Such failures have, however, been less numerous when the plastic mixture has been used than with other methods. On the other hand, filling injection or grafting, or, even better, orthoplasty by a flap, practised after complete sterilization of the cavity has been secured, is strongly indicated.

Timid, limited operative attempts are almost always followed by recurrence, and they favor the extension of the osseous infection. The

number of patients upon whom it has been necessary to operate several times is considerable. In twenty-five cases of chronic osteomyelitis under the personal observation of the author, twelve had already been operated upon once in another hospital; four, twice; one, seven times, and one, eleven times.

Extensive and complete intervention done early gives to the patient the maximum of chance of definite cure. This is obtained after an interval of time which varies from a few weeks to six or seven months. He refers to fifty cases reported by Churto, who claims to have secured fifty complete cures. Jacob himself in forty-two cases personally operated upon had had thirty-eight of them discharged from the hospital cured; the remaining four were still under treatment and in good course of healing.

However, it is prudent to make some reservations. The osseous infection is extremely tenacious, and it is well known that it can be reawakened after years of cure apparently absolutely perfect. It is none the less true, however, that the early and thorough intervention is the only treatment that offers to the wounded the best guarantees against such recurrence. One may hope that as the result of such work one may no longer see reënter into the surgical service patients who have been operated upon several times and among whom the extension and the gravity of the lesions, and the general poor state resulting, finally make amputation imperative. He mentions especially one patient in whom he had been compelled to amputate the thigh as the result of a fistulous osteomyelitis of the femur consecutive to a gunshot fracture sustained forty-six years before, in 1870.

Sir George M. Makins, of London, said that the characteristics of traumatic osteomyelitis resulting from wounds inflicted by shell fragments vary according to whether the affection has been caused by the penetration of a foreign body carrying with it bits of earth and of clothing, and, second, upon the gravity and extent of the injury done to the soft parts in the neighborhood of the injured bone. It is in such initial phases of the affection in which reside the points of special peculiarity of a pathological character, while its later development differs but little from what has hitherto been observed in civil hospitals.

He referred to the brochure published by Martin and Petrie on "Phases of Infection Preceding Traumatic Osteomyelitis from Shell Fragments," their report having been based upon thirty-two cases of shell fractures of the bones of the limbs observed in a military hospital in France during the course of the year 1916–17.

The material for his own study was always obtained from an amputation operation, or from a resection of the large joints. It was kept on ice during the short period which intervened between the moment of the operation and that in which they were able to subject it to bouillon culture. The stages of infection, therefore, to which the study was given

were those which preceded the full development of osteomyelitis. The progress of the microbic infection through the bone was studied by making transverse sections of the affected bone at regular intervals, taking away each time for bacteriological examination pea-sized fragments. Finally to avoid all error coming from the synchronous presence of another source of intrinsic septic infection, they removed during the operation blood from a vein, which also was afterward subjected to analysis.

In every infected comminuted fracture the first vehicle of propagation of the microbes through the bone is the blood-clot borne upon the bony fragments and by these brought between the walls of the fissures. Microbes may thus be carried to a portion of the bone, or to a joint distant from the primary seat of the infection, and all the parts of the bone may be infected unless the development of the bacteria is stopped by surgical intervention.

A second source of propagation is penetration; that is to say, by the direct development into the substance of the bone of germs which have penetrated into it at a right angle with the fractured surface.

All portions of a comminuted fracture are not infected simultaneously. At the moment when the wound is produced, germs are implanted only in the parts touched by the projectile, but from that point they propagate themselves into the tissues by a regular progress until they are stopped by a natural barrier or by surgical intervention.

The rapidity of propagation depends directly upon the two factors—the amount of infection brought in and the length of the fissure exposed to infection by the wound. The first of these factors depends upon the presence of the projectile in the wound together with its agents of infection, dirt, fragments of clothing, etc.; the last, upon the degree of muscular laceration in the neighborhood of the bone.

Fissures are important by reason of the readiness with which they transmit the infection to points distant from the principal fracture. These present an initial resistance to the passage of bacteria when the concentration of such bacteria is not too great, or their path of entrance not too ready; that is to say, when the extirpation of all the débris attending the wound and the taking away of lacerated tissue have limited the infection to the tissues about the chief fracture.

The Penetration of the Bone by the Germs.—It has been experimentally established that the degree of penetration depends first of all upon the abundance with which bacteria have been implanted upon the surface of the fracture. Bacteria have been found in a bone not submitted to surgical cure at a depth of 10 cm. Again, the power of penetration varies according to the type of the germ, so that the variety of the infecting agent should be taken into account in each particular case. Nevertheless, since mixed infections are frequent, and it is not always possible to make a rapid bacteriological analysis of the micro-organisms introduced

into the wound, there remain other points more urgent to be discussed.

The degree of bacterial infection upon the fractured surface at a given moment depends directly upon the following factors:

(1) The time elapsed since the wound.

(2) The blood supply.

(3) The surgical cares which have been given to the bone or to the soft parts.

(1) *The Influence of Time Elapsed Since the Wound.*—Although it is hardly possible, whatever the variety of the case may be, to give an exact formula as to the rapidity of penetration, observations made in sixteen cases of different fractures, in which the other factors played an insignificant part, enable us to come to the following conclusions, namely:

In cases where a septic wound has been submitted to adequate surgical treatment and to systematic cleansing the infection of the bone attacked may limit itself entirely to the superficial surface. The force of penetration reaches its maximum during the first days after the production of the wound and decreases to such a point at the end of the first week that a reaction of immunity is established. Although the data are too few to permit the enunciation of a rule based upon statistics, we are nevertheless warranted in making the general statement that the penetration of germs takes place in the majority of cases at the rate of 1 cm. to every sixty hours.

(2) *Blood Supply.*—The influence of a slackening in the circulation of the blood upon the development of germs (anaërobia particularly) through the tissues is known and has been demonstrated with precision in the case of infection of the muscles. The same general principles apply equally to bones, but the anatomical structure of the latter determine certain deviations upon secondary points. Many experiences have shown that one cannot attach too much importance to the question of the blood supply, and that every interruption in such supply, whether as the result of the initial trauma or as the result of surgical intervention, is a usual precursor of chronic osteomyelitis.

(3) *Surgical Treatment of the Bone.*—The reporter confines his observations in this communication to operations directed to spongy tissue rather than to the compact wall of the bone and the marrow. The fractures which have been subjected to study with the greatest care have been those in which the shell fragments have penetrated into the articular extremity of the bone of the limb. Around the fragment is found a layer of necrotic tissue formed by blood-clots and crushed bony trabeculæ. This layer is in immediate contact with fragments of infected clothing; beyond extends a zone of spongy tissue devitalized but not crushed, the depth of which varies according to the force of the blow. As long as the layer of necrotic débris upon the surface of the fracture has not been taken away the drainage of the wound is powerless to resist the progress of septic penetration. If, on the contrary, after the lacerated tissue has

been cut away, the fracture is cleansed until there remains no débris, the entire remaining bone may be made capable of resisting infection until a protective barrier of granulating tissue is established; or by adequate drainage of the bone wound the bacterial penetration as a source of suppurative osteomyelitis may be almost entirely removed.

(4) *Surgical Cares Given to the Wounds of the Soft Parts.*—Imperfect drainage of a wound increases the facility with which the bacteriological penetration in the fractured surface takes place. The number of germs brought into contact with the open osseous surface is continually increased and bacterial penetration may reach a minimum depth of 2.8 cm.

The most common of the varieties of bacteria and the degree in which the variety of the germ may influence bacterial penetration is shown in the following table:

Variety of bacteria	*Average penetration*
Streptococci	10 cases, 2 cm.
Staphylococci	6 cases, 1.5 cm.
Anaërobia	6 cases, 0.8 cm.
Bacilli coli	3 cases, 0.7 cm.

CONCLUSIONS.—*Pathology.*—The infection of a fractured bone may propagate itself slowly from the original seat of infection. The advance of the germs is effected both by extension along the surface of the fractures and by direct penetration into the bone and the soft parts. The rapidity of the propagation of the disease reaches its culminating point during the first days and may be increased by insufficient blood supply and by defective drainage of the bone and soft parts.

Treatment.—The rapidity of the progress of bacterial infection in a fractured bone permits the formulation of the following axioms, the application of which is important in securing consolidation of fractures from certain projectiles. These axioms are:

(*a*) Operation with the briefest delay possible. It should be a question of hours, not of days. The surgical intervention should be based upon the examination of the particular pathology of the case. Primary healing has the least chances of success when the muscle is much lacerated and particularly when the injury of the muscle is parallel to the fissure and when the circulation is seriously interfered with.

(*b*) The excision of the wound should include not only the taking away of the necrotic tissue, clots of blood and foreign bodies (including therein fragments of bone separated from their periosteal connection), but also that portion of the bone lying in contact with the projectile. The depth to which the soiled part should be taken away varies according to the time which has elapsed since the wound had been sustained. Although it may not be stated exactly, one can nevertheless calculate such depth to have reached about 5 cm. at the end of twelve hours, when the sub-

sequent phases of an osteomyelitis which has reached its full development may be summed up as follows:

Almost every case is accompanied by necrosis, varying from a slight superficial exfoliation of the bone to total necrosis of the whole thickness of the bone for a variable length beginning from the initial wound. The bone which survives in the zone of inflammation presents symptoms of rarefying osteomyelitis which manifest themselves more especially in the cancellated bony tissue. Rarefying osteomyelitis is sometimes followed by secondary sclerosis of extreme density, and particularly in the presence of a localized injury not severe enough to cause fracture, often containing a foreign body. The propagation of the infection is not always continuous. Healthy portions of bone may alternate with infected portions, or with small localized abscess cavities; in which latter cases the infection is probably due to infected thromboses.

Another characteristic of osteomyelitis resulting from infection of the fracture produced by shell fragments is the tendency to produce an excessive callus extending over a large surface. This tendency is due to the scattering of osseous elements throughout the surrounding tissue by the initial injury and by the fact that the infection stimulates the formation of callus. An example is the osseous masses which after amputation often block up the medullary cavity and envelop the end of the bone.

From the surgical point of view, a notable fact is the slightness of the symptoms observed in the part attacked during the first phases of the disease. This is explained by the tendency of the disease to limit itself at first to the portion of the medullary canal which is widely open. The serious subperiosteal modifications manifest themselves later and a diffuse and progressive suppuration under the periosteum is rarely produced, so that the symptoms of osteomyelitis are often those of a general toxæmia or more rarely of septicæmia. Cases of characteristic pyæmia accompanied by secondary abscesses in other parts of the body have been rare, although the mode of propagation of the disease by progressive invasions originating from localized points may be considered as being of a nature identical with that of pyæmia.

The essential treatment of the osteomyelitis arising in cases of osseous fractures of bones should be prophylactic. The infection propagates itself comparatively slowly, and it is sufficient to cleanse at once the infected surface to a depth of 5 cm. to prevent the disease. All surgeons who have studied the question are agreed that the solution of the problem depends above all upon the resistance to infection of the tissues about the bone attacked, and that it is necessary in consequence to make certain the total absence of germs in such tissue rather than to direct surgical attack to the bone itself.

The prophylactic treatment of fractures may then be summarized as follows:

(*a*) Complete mechanical cleansing of the injury of the soft parts.

(*b*) Careful removal of free or displaced fragments.

(*c*) In the case of shell wounds, particularly those involving the cancellated tissue of the bone, the taking away of the surface which has been brought into momentary or prolonged contact with the projectile.

Ideal primary union of the wounds is rarely obtainable, and in the conditions prevalent in actual war should not be attempted except in certain exceptional cases.

Closure of the wound on the twenty-first day after the fracture is generally possible. It protects the patient against the dangers of a possible return of infection.

The bone of an amputated limb is often already the subject of an osteomyelitis at the time of the operation. If, however, the operation is an immediate one, there is a chance that the bone will still be healthy. In case of immediate operation it is recommended that the sawing through of the bone be conducted under the current of an antiseptic solution, and in doubtful cases the section should be followed by the application of a powerful antiseptic. The chief blood-vessel of the limb should not be ligated above the level of the stump, except for some special reason, in order that as great a degree of vitality as possible may be maintained in the tissues about the bone involved.

The treatment of osteomyelitis developed in the bone remaining after amputation may be necessary in cases of immediate and progressive infection. In such cases the granulation tissue upon the surface of the wound and the rarefied bony tissues, as well as every foreign body, should be taken away by means of a curet; then free drainage is established from the exposed medullary cavity. Throughout the treatment every effort should be directed toward maintaining the soft parts in the best state possible. If such measures do not result in staying the disease, a second amputation is indicated, even the entire ablation of the bone.

In some cases the taking away of a sequestrum may lead to a cure. In older cases, again, it is sometimes necessary to remove the sequelæ of osteomyelitis before being able to adapt an artificial limb to the stump.

In cases where osteomyelitis and suppuration persist in the fractured bone the first indication of treatment is to make sure of free drainage of the medullary cavity and of the space included between the chief fragments. Such drainage can sometimes be established only after the removal of a sequestrum, in others only after the ablation of fragments which by their shape or their position form an obstacle to drainage or sterilization of the cavity. If the patient suffers from toxæmia, or severe and prolonged septicæmia, amputation is necessary, and complete extirpation of the infected bone may be recommended.

In cases of prolonged suppuration having its source in a strongly infected medullary cavity, openings for drainage should be made along

the whole length of the bone, or the infected medullary cavity may be laid open throughout its whole extent. When the development of granulations upon the surface of a bone exposed and deprived of periosteum is slow, it may be hastened by boring a certain number of holes into the bone.

If at the side of the fractures important thickenings of osseous tissue develop, without solution of continuity, linear osteotomy or a removal of a portion of osseous tissue may hasten the cure and remove the pain.

In certain cases large masses of callus, accumulated through the infection or inflammation in certain regions, as, for example, in the abductor muscle, may be taken away in order to prevent deformity or to restore the function of the muscle invaded, or to restore to the limbs freedom of movement.

M. CONRAD said that the treatment of traumatic osteomyelitis has as its well-defined object the sterilization of the wound, so that a secondary closure might later be secured under bacteriological control. The osseous infection has benefited very greatly from the adequate adoption of this treatment. Three indications have to be met: (1) The fight against infection by one of the methods generally adopted to-day (of Carrel, Wright, etc.); (2) the removal of all foreign bodies, fragments of clothing, projectiles, etc.; (3) the removal of splinters.

When the bacteriological control permits the delayed primary suture, or, as is most frequently the case, the secondary suture, the osteomyelitis will have shared in the benefits of the general treatment and will be cured; but when the treatment has been poorly conducted, either through faulty technic or because of the wound having been sutured too early, latent infection of the wound is reawakened under the influence of a new traumatism, or often by some cause not recognizable. All the symptoms of osteomyelitis may then reappear with greater clearness. An abscess is formed, the surgeon opens it, and very regularly the wound heals with the persistence of a fistula. At other times the gunshot wound, although not subjected to secondary suture, closes by granulation without a persistent fistula.

Commonly, when one speaks of a traumatic osteomyelitis resulting from gunshot wounds we think of the patient at the stage in its evolution in which the formation of a fistula has taken place. This is an error which should be earnestly protested against.

How is it necessary to treat the bearer of a fistula?

At first, it is necessary to care for the skin-eczema which too often contaminates the circumference of the fistula. This is easily accomplished by aseptic dressings. Then by adequate interference may be taken away the anatomical cause which produces the fistula. The fistula may be kept up indefinitely by a foreign body; by sequestra free at the bottom of the fistula, or confined by osseous callus; eburnated callus poorly

nourished, or by callus with cavities filled with fungosities, with pus and with small sequestra; false joints with intervening sequestra, or whose extremities are necrosed or the subjects of osteitis and on the way toward necrosis; the stumps of amputations, too often the subjects of osteitis.

In every one of these, to obtain a definite cure, it is necessary that the offending condition should be removed or resected. In each case examination indicates the technic to be followed.

The speaker, however, submitted some general ideas as to treatment. In particular he emphasized as important that the track of the fistula should be subjected to stereoscopic examination to determine its anatomical relations and the presence of sequestra or of foreign bodies, furnishing valuable information to the surgeon in choosing his path of attack, in establishing his operative technic, in recognizing the anatomical causes of the fistula, and their nature, and their number.

When everything has been removed the cure is definitive without danger of recurrence. The path of access should always be very free. When attack is made upon a flat bone, all the diseased parts should be resected.

Especial mention should be made of the vault of the cranium, where too often are found sequestra involving the internal table, notwithstanding the sound condition of the external table. The short bones should be resected, although in some, as in the calcaneum, may be practised some cartilaginous évidement.

So also, in dealing with the diaphyses of the long bones, care is to be taken to avoid penetrating into the joint. In a diaphysis of the long bones the cavity should be freely uncovered. Diseased bones should be cut away down to healthy tissue. After the foyer has been cleansed, the margins of the osseous wound should be clean, smooth, regular, taking away enough to permit the skin to cover them and to be held in contact with its surface throughout the whole wound.

He did not favor the use of pastes (Mosetig, Beck). They do not take away the cause of the evil. At most they can bring an apparent cure, but recurrence is inevitable.

The fistula is ordinarily accompanied by atrophy, by musculo-tendinous stiffenings which often are extensive enough to render the limb completely useless even after the final cure of the fistula. Mechano-therapic treatment has a place in the care of these lesions, but it will not produce its full effects in cases still curable until the anatomical cause is taken away; until the fistula is definitely suppressed and the cure of the musculo-tendinous stiffenings is no longer hindered.

The author advocates early intervention, because the cure can be obtained only by taking away the cause which lies at the bottom of the fistula; because it is of greater importance in the contest against the musculo-tendinous lesions in the neighborhood to institute as rapidly as possible mechano-therapic treatment, the good effects of which cannot be definite unless the osseous lesion is cured.

A single exception is possible; certain sequestra, such as those which form in the extremity of ununited fragments of long bones, require some time to separate themselves. In such exceptional cases the surgeon looking out for them will readily judge as to the moment for intervention.

In general, the author advocates prompt operation as soon as the fistula with its special characteristics is clearly established. He resects, without longer waiting, the extremities of fracture fragments, the necrosis of which is to be expected even before the sequestrum has limited itself, relying upon the good effects of the Carrel treatment to strangle the osteitis in its course of evolution.

Conclusions.—The conference, after the presentation of these papers, adopted the following minute:

" As to the treatment of chronic osteomyelitis:

" (1) Osseous infection is produced by the same mechanism as infection in other gunshot wounds. It is propagated in two ways, either by steady progress through medullary and compact tissue, or to a distance along the fissures. The penetration through the osseous tissue is generally slow and limited.

" (2) Among the bacteria which first penetrate are streptococcic, staphylococcic, enterococcic, and more rarely anaërobic germs. In the microbic flora of the subacute or chronic suppurations of the bone they find most frequently the same bacteria.

" (3) The treatment of chronic osteomyelitis is first of all preventive; that is to say, simply the treatment of the foyer of the fracture.

" (4) The treatment of established osteomyelitis is purely surgical. It should be instituted early. It consists essentially in:

" (*a*) A wide opening of the infected focus;

" (*b*) Careful search for and ablation of all sequestra and foreign bodies;

" (*c*) Converting cavities into plane surfaces.

" (5) These operative steps accomplished, two methods remain;

" (*a*) Either the immediate closure of the wound, secured, if necessary, by flap autoplasty;

" (*b*) Chemical sterilization of the wound and secondary autoplasty as required to fill in the osseous cavity and to permit of its suture.

" The latter method is most generally applicable."

FINAL RESULTS OF THE TREATMENT OF FRACTURE OF THE SHAFT OF THE FEMUR*

Dr. Th. Tuffier, of Paris, contributed to the Interallied Surgical Conference, held in November, 1917, the result of his studies on the results which had been attained in the treatment of fractures of the femoral diaphysis among the French troops.

The material upon which he had based his report included 16,392 cases. All the information received with regard to these cases was not of the same value; a large number could not be used because in the earlier months of the war the records were not kept with as much care as later. Moreover, all these injuries dated from the period extending from August, 1914, to December, 1916, a period particularly unfavorable in the treatment of fractures. For this reason the results obtained were unfavorable. Another cause of error is that in order to establish the exact gravity of such accidents it is necessary to know the precise number of fractures of the femur since the beginning of hostilities, in order to know in what proportion the results obtained have been unsatisfactory. Such information is not available; though it is impossible to obtain them at the present moment, he had every reason to believe that especially the unfavorable cases were generally included in the histories obtained, since he had had to do with invalided or pensioned patients.

The seat of fracture has in this plan a very marked importance. It is the fractures in the lower fourth, or in the upper fourth, of the bone which give the worst results.

Methods of efficient treatment applicable to fractures in general are often unavailing in fractures of the femur. Out of three hundred thousand invalids pensioned on account of gunshot wounds, there were 119,663 fractures, of which number 16,392 were fractures of the thigh. These thigh fractures were under treatment from four months to thirty-seven months, an average of fifteen and one-half months. The best statistics are furnished by the Hospital for Fractures at Châlons, which reports an average of treatment of ninety days. The functional state in all was reduced to a point which made their degree of invalidity exceed 10 per cent., for below that point the wounded were not invalided. As to the various degrees of invalidity, 22.42 per cent. were reduced to an absolute functional loss of power of the limb. A lameness of variable degree, spontaneous pains, pain provoked by walking, even to the extent of the permanent use of crutches—such are the troubles constantly noted in these cases.

As to the causes of these disabilities, in the first rank is bone infection, chronic osteomyelitis. It is almost constant in the history of these injuries. The difficulties and the length of its treatment, the necessity of several suc-

* *Comptes-Rendus de la Conférence Chirurgicale Interalliée pour l'étude des plaies de guerre*, 3d session, 5–8 November, 1917, p. 233.

cessive operations to bring it to an end, play a capital rôle in the later disabilities due to these fractures. Second, the shortening of the limb is constant and varies from 1 to 20 cm. Out of 883 cases, 43 were shortened at least 3 cm.; 191, 6 cm.; 225, 9 cm.; 390, more than 9 cm.

When this shortening is alone and exceeds 5 cm., it determines marked trouble; but it is frequently associated with rotation and angulation. It is generally due to overriding of the two fragments, much more rarely to the loss of substance completely separating the two extremities of the bone. In all the cases where it is due to overriding of the fragments it is a surgical question. This is a point upon which too much insistence cannot be placed. Outward rotation of the lower fragments aggravates notably the trouble in walking. It is present in 70 per cent. of the cases. Lastly, the angulation is of the classical form; that is to say, with its convexity forward and outward. In numbers of cases the deformity is not only curved; it is more than a curve, it is an angle. The loss of function due to these shortenings can be avoided in most cases, excepting only the shortenings due to real loss of bone. The rotation, and especially the angulation, is always due to imperfect surgical treatment. After consolidation has been accomplished, it does not follow that the patients are guaranteed from accidents of osteomyelitic attacks in the callus.

These may present themselves under two aspects clinically, in general of slow development. At the beginning a sense of pain in the limb; a sensation of heat at the level of the callus or of one of the cicatrices, then a painful localized swelling with redness and œdema. These symptoms last for some days, then improve and disappear, only to manifest themselves again some weeks or some months later and to end by the formation of a fistulous track. Or a simple traumatism or overuse may provoke the signs of acute osteomyelitis with suppuration. A fracture of the thigh once infected is never free from the possibility of such accidents, at any period of its existence. He had seen operated twenty-five years after their fracture men who had been wounded in the war of 1870. What establishes their gravity in any general estimate of late results of treatment of fractures of the thigh is the frequent powerlessness of means of treatment.

Free resection, wide, deep, of the whole focus until the healthy bone is exposed; the prolonged disinfection of the surfaces and of the old cavities; their closure with bacteriologic control, and their being filled with living tissue may give success that curetting and restricted resections will fail to establish. The general therapeutics is, in fact, that of osteomyelitis.

In addition to such osteomyelitic attacks, irregular and deforming callus is the rule in fractures of the femur which have undergone suppuration.

Of 161 cases of deforming callus examined by the X-ray, he found 94

cases of excessive deposit of irregular shape invading muscles and becoming, by their interference with muscular action, a cause of disability; that is to say, 58.4 per cent.; 37 cases of angulation callus; 21 cases of considerable overriding; in 9 cases the fragments presented such a degree of overriding that amputation had to be practised; but the callus itself may be in fault, although such cases are relatively rare. Pseudarthrosis, which is not to be confounded with prolonged delay in consolidation, is especially grave. It is fortunately less frequent than in the bones of the forearm and arm, which occurred upon an average in 14 per thousand cases. Further inquiry at the orthopædic service at Paris as to this proportion elicited the fact that in that service 10 pseudarthroses of the thigh had been observed and 30 cases of soft callus, while the fractures of the arm had given 500 pseudarthroses, and fractures of the leg 400. It is very difficult to establish the causes of such pseudarthrosis and to know whether the extent of the removal of the splinters may not be the chief cause but it seems in all cases that the suppuration of the two osseous extremities may be the most frequent determining cause. If suppuration has been prolonged, the treatment of such accidents is always grave and is accompanied with loss of functional power in the limb and varies with the length of osseous substance lost. When it is not extensive, the freshening of the bony ends, their suture by metallic plate or a graft, with or without osteo-periosteal clothing, constitutes the method of treatment of choice.

Subjects of surgical treatment also are the ankyloses of articular stiffnesses affecting the knee and the foot or the hip. These accidents are extremely common, amounting to 76.2 per cent. of all cases, and have played a very important part in the determination of the functional trouble presented by the patient. Stiffness of the knee occurred in 38.8 per cent.; complete ankylosis in 22 per cent.; stiffness of the knee associated with complete or incomplete ankylosis of another joint was met with in 35.6 per cent. The other articulations are less frequently affected; the hip in 5.55 per cent., the foot only in 4.12 per cent.; but it is the associated ankyloses of the hip, of the knee and of the foot which are the most frequent—the knee, the hip and the foot in 1 per cent.; the knee and the hip in 6 per cent.; the knee and the foot in 12 per cent.

These frequent ankyloses, single or compound, in joints which have not been affected by the traumatism show imperfection in the surgical treatment. An early and properly conducted mobilization would save the patients from such grave complications.

The author remarks that many times among the late distant results of fractures of the thigh they met with coincident mechanical troubles, the ensemble of which alone was the source of grave loss of power. A relatively slight shortening with considerable rotation becomes quite serious; if to it is added a stiffness of the knee, as happens in 46.6 per cent. of the cases, the loss of function of the limb becomes considerable and the degree of infirmity is notably increased. To prevent such accidents,

therefore, should be a matter of constant attention by surgeons treating such injuries.

The operative treatment of these deformities and these joint lesions includes the straightening of the limb and the mobilization of the joints.

The straightening of the limb in cases of angulation or axial rotation of the fragments is accomplished by osteotomy. Two conditions may be present, determined by the existence or non-existence of an osteomyelitis.

In the first place, the resection of the callus to its full extent and the denudation of healthy bone, and the methodical disinfection after the method of Carrel, have given the best results. If, however, there are no infectious phenomena, a wait of several months should be allowed before practising simple osteotomy and the reduction of the deformity, whether by traction through an apparatus, by immobilization, or by suture of the bone. In case of shortening with angulation, osteotomy and reduction may even produce an elongation of 6 cm. in extent.

But outside of operative treatment, examination of fractures of the thigh shows very often that functional troubles are due to muscular atrophy involving one or a group of muscles. The author has seen in a number of cases, by simple education of the defective muscles, a restoration of the power such that, notwithstanding the persistent bony deformity, the functional trouble disappeared in great part.

Besides such muscular trouble, one finds at a distance, in fractures of the thigh, vasomotor troubles, which appear and persist during the first months. Often they produce delay in cure; but when such œdemas are considerable and become chronic and hard, when the vasomotor troubles characterized by redness of the limb below are considerable, they become a complication relatively grave.

Finally, trophic troubles may be due to concomitant injuries of the large nervous trunks; they are relatively rare, having been found in only 91 cases. Of these 36 were lesions of the sciatic, 42 of the external popliteal, 5 of the internal popliteal, 3 of the external and internal popliteal, 4 of the crural nerves. These injuries are particularly grave, for secondary suture of these large trunks is unreliable.

The primary cause of defective results in the treatment of fractures of the thigh sustained during the first three years of the war is recognized as infection of the wound and of the osseous focus, for the non-infected fractures give results equal to those in times of peace. The infection produces secondary osteomyelitis, the duration of which is uncertain and which necessitates a prolonged treatment. The long duration of the treatment, the difficulty of making the dressings and of maintaining at the same time exact coaptation, explain the frequency of the alterations in the axis of the limb, the angular deformities, the deposits of deforming callus, the musculo-periosteal adhesions and the vicious cicatrices, all of which result in loss of function. The shortening of the limb is the factor of least importance in the scale of these deformities.

These results can be, and will be, very notably bettered. The primary or secondary closure of these fractures will prevent all the accidents due directly or indirectly to the osteomyelitis; that is, rapid disinfection will make it possible to escape all those infectious complications which lead to prolonged suppuration, even amputation; by shortening the duration of the treatment which will protect from accident on the side of the knee, the hip and the foot, and, finally, they will permit the surgeon to direct his whole attention to the orthopædic question, and the overridings and the deviations in axis will become by so much diminished. The joints of the knee and of the foot will no longer be left stiffened, and false joints will diminish in frequency.

The report submitted gives a résumé of a bad period in therapeutic history, and the reporter did not doubt that a review of the results obtained during a later period would show results infinitely more favorable.

LATE EXTRACTION OF MISSILES IMBEDDED IN THE LUNG

(*Extractions de projectiles intra-pulmonaires chez d'anciens blessés.*) DR. R. OLIVIER* says that in January, 1916, he was placed in charge of a surgical service in which were included thirty cases of wounds of the chest in which the projectiles were still retained in the lung. Of these only fifteen were subjected to operation. In some of those that were not operated upon the small size of the foreign body and the absence of all symptoms contraindicated intervention. Others refused to permit themselves to be operated upon, affirming that they were doing well enough and they saw no necessity of undergoing the surgical attack. Of the fifteen who accepted operation, some did so because they were suffering from various symptoms which caused them anxiety, the others because they could not bear the idea of retaining a foreign metallic substance imbedded in their chest.

Of all these men, the most recent wound dated back five months. The symptoms which they presented were for the most part vague, such as variable interference in respiration and some painful phenomena. All were able to assist in hospital duties and all had been actively employed in the care of the hospital garden. All had borne without pulmonary disturbance the winter's storms. Several since their wound had made another campaign and had supported its fatigues without trouble. It is proper to say that these latter were energetic men. Only two of the patients among those under observation presented a serious condition dependent upon the presence of the projectile, indicating clearly the necessity of intervention.

These two wounds dated back to the battle of the Marne. Since receiving their wounds they had not ceased to suffer. In one, simple hemorrhages were provoked by any slightly prolonged effort; in the other, besides repeated hemorrhages, sometimes severe, there was constant expectoration of foul pus, particularly abundant in the mornings. In both these cases the general state was seriously affected. The first of these was subjected to operation, with the result that the hæmoptysis had ceased. The other, notwithstanding his grave condition, declined operative relief. The symptoms in these cases, in most of them, were, however, very slight and seemed more frequently to be due not to the projectile, but to the remains of ancient pleural effusions. As to whether such retained projectiles might later provoke accidents is uncertain.

In the course of the operative work the author had always been surprised at the very slight extent of the pulmonary lesions which were found. There had been met every degree of pleural adhesions, from almost total adhesion down to some very slight and loose adhesions; but when the projectile was exposed in the pulmonary parenchyma, very

* *Lyon Chirurgical*, May–June, 1918.

frequently the foreign body was surrounded by a very thin sac well limited, and immediately outside this the pulmonary tissue became healthy, supple, elastic. The condition was quite otherwise when the projectile by its presence was determining the trouble. Then there was more or less of intense local reaction, with the sac much less clearly limited; sometimes an abscess around the foreign body, which lesions were accompanied with clinical manifestations. The author asks again whether, when such clinical manifestations are absent, the projectile has become definitely inoffensive?

It is certain that in case of the development of subsequent pulmonary disease a retained projectile may easily become an additional cause of an abscess of the lung or of pulmonary gangrene. Even without apparent cause an abscess may be produced around such a projectile, as has taken place occasionally in other parts of the body.

The author discusses the question of anæsthesia in cases in which projectiles are to be extracted from the lung. As a rule, he had employed general anæsthesia. He never saw any serious accident excepting in one case, in which he was obliged to suspend the operation. The ether and chloroform were almost always well supported, and there were no post-operative accidents due to anæsthesia. He had, however, been surprised with the good results which attempts at local anæsthesia had given him. He made use of a 1 per cent. solution of cocain or 1 per cent. adrenalized novocain. With this solution the tissues in the whole operative zone were freely infiltrated. When the rib was exposed, the needle was directed toward the root and parallel to the edges, and several cc. were injected around the intercostal nerves. With this simple local anæsthesia he had always been able to make whatever intervention with the lung was necessary and to extract the projectiles by whatever method was required.

In one case, in which in the absence of a primary fixation of the lung a total pneumothorax occurred, the lung was drawn out through the wound, the missile removed and the lung was sutured, followed by suture of the wall, the patient himself did not perceive the occurrence of the pneumothorax. The only result was that the respiration became a little superficial; the pulse was not disturbed and the operative course was facile. In other cases, also, he has extracted projectiles through an opening deliberately made in the pleura, and always the pneumothorax was well supported. It was very evident that but little gravity attached to the operative pneumothorax. It is well to know that even with simple local anæsthesia thoracotomy with pneumothorax may be resorted to if it is indicated.

The whole history of surgery of the lung has been dominated by fear of the dangers of the pneumothorax much more than that of the operative lesion of the lung. The latter is generally well supported when it is done with prudence. That in the surgery of the lung little gravity attaches to the pneumothorax as an operative step has further been

demonstrated by experience in wide thoracotomy for search for projectiles according to the method of Duval. The only precaution to be observed is to produce such a pneumothorax slowly. Frequently the suture of the lung is not sufficient to prevent more or less bloody effusion into the pleura taking place from the lung; more or less serious infection may result according to the virulence of the infecting bacilli, varying from a simple pleural reaction with serous effusion, which is the most frequent condition, to the most grave putrid, purulent pleurisies.

It has seemed to the author that the operative consequences were the more serious when the pneumothorax had been created through a high thoracotomy, the gravity increasing in measure as the summit of the pleural cavity is approached. This is probably due to septic liquids tending to collect at the lowest point and infecting thus a much larger extent of surface. He has noted also that the pleural reaction accompanied with more marked cardiac phenomena had been notable in those cases in which the internal face of the lung was involved in the extraction of the projectile.

In those cases in which operative intervention had been employed where the lung was adherent to the pleura, the better progress of such cases was due, in his opinion, not so much to the absence of the pneumothorax as to the more direct drainage of the lung sac in which the projectile had been imbedded by a drain, which brought directly to the outside any septic products, with the formation of a zone of adhesions separating the large serous cavity from the pulmonary operative focus.

When forceps extraction is possible, the tract created is of small diameter, closes immediately because of its obliquity, and produces no pneumothorax, no effusion into the pleura.

The morbidity attending the extraction of foreign bodies of the lung may be more or less great, according to the method employed; but when a sufficiently long period has elapsed since the date of the wound, the mortality will be very slight. Marion in 150 cases had but one death. Though the risk may be slight, do the final results obtained warrant its practice? One can reply in the affirmative without hesitation in those cases in which the presence of the projectiles is producing accidents, such as hemorrhages, purulent expectoration and other phenomena of pulmonary reaction. All such symptoms disappear after the extraction of the foreign body. This fact appears to be clearly established, but it is far from being clear that relief can be expected from such symptoms as pain and respiratory difficulty in prolonged efforts and in severe labor. The cases operated upon by the author, five months later when examined, were found to present a functional condition identical with, or even less satisfactory than, that which had preceded operation, excepting in those cases in which there had been present hæmoptysis and purulent expectoration, which phenomena had disappeared quickly and had not returned. Radioscope showed the existence of a pleurodiaphragmatic pathology. which

did not exist before. Examination made in these cases later showed the same functional trouble. The author believes, however, that they will diminish in time.

Technic.—Four methods are mentioned: (1) the method with fixation of the lung (the method of Marion); (2) the transpleural method with pneumothorax (method of Duval); (3) the method of extraction with forceps guided by fluoroscope (method of Petit de la Villéon); (4) a mixed method, secondary fixation of the lung after extraction.

The method of Duval is rapid, elegant, everything that can be wished for when its object can be realized; that is to say, extraction of the projectile and fragments of clothing, and cleansing of the pleura. When the ribs are separated by powerful instruments it is easy to explore the lung. The projectile is generally felt, the lung is brought to the outside, the foreign body is taken away and hæmostatic suture can be done. It is a perfect method when the foreign body is seated upon the external face of the lung. It is quite otherwise when the region involved is the posterior mediastinal region. The extraction, and, above all, the suture, are then very difficult. In the author's opinion, this method is the best for danger-making missiles where it is necessary to choose between possible immediate accident and later septic accidents, which are very greatly reduced in their seriousness as the result of the operation.

The author has subjected three patients to operation by this method, and in all cases the later consequences were simple. The first case was accomplished with a purulent pleurisy in consequence of an accident that he should have avoided. There were two projectiles, one of which fell into the pleural sac and produced a purulent effusion, which later was overcome by Dakin irrigations. The second also was a pleurisy, at first serous, then purulent. The projectile was seated at the bottom of an interlobar fissure and the hæmostatic suture was almost impracticable. In the third case everything passed smoothly and the suture of the lung was carefully done. Some serous effusion followed, but without serious consequences.

The method of Marion, in the presence of existing adhesive fixation of the lung, was followed in eight cases. The simplicity of the operative steps and all its later consequences was astonishing. There were no complications in these cases and the eight patients were up by the twelfth day. In all cases the projectile was found except in one case, in which there was an error in the localization. Some of these projectiles were situated very deep. The liberation and extraction of the foreign body was effected with great care, never attempting to take away the projectile by a forceps upon the finger, but always the operation was done with full sight, not hesitating to make a very large opening; indeed, this opening was much more a crowding back than a wound. There was no hemorrhage.

For very deep projectiles the operation may be conducted in two

steps. In the first step one goes as far as the projectile. If the extraction appears dangerous, a tampon should be inserted. Some days later the case can be resumed, and the extraction, according to Marion, is then greatly facilitated. However deep the track through the lung tissue, its walls fall immediately together and the track does not seem to produce any complication.

The principal objections attach to the fact that a zone of solid adhesions is created around the site of the interference, and also that only the foreign body is seen and the condition of the pleura is not ascertainable.

In the cases reported by the author the post-operative course was always excellent and identical. The temperature charts seemed copies one of the other, an elevated curve for three days up to the taking away of the drain. As soon as that was taken away the temperature fell and remained normal. The small drain orifice cicatrized, and by the twelfth day the patients were all up. Some spat pus for two or three days, but all quickly returned to a normal state.

The method with secondary fixation of the lung, as employed by the author, was the result of two incidents. The first happened in the course of an attempted extraction by the method of Marion in which fixation was not present. The incision opened at once the pleural cavity instead of the lung. In the second case, in the course of an extraction by the transpleural method, with pneumothorax, the operator found himself confronted by an abscess surrounding the projectile. After incising the lung and extracting the projectile, with opening of the abscess, he made a careful encircling suture, which united the lung and the costal pleura, and inserted a drain. The later progress of the case was perfectly simple.

The extraction of the projectile under the guidance of the fluoroscope, the method of Petit de la Villéon, was used in some cases. At first sight this method seemed the better, both from the point of view of the facility in extraction and also the simplicity of the aftercourse. It is not so. It is a blind, unsurgical method. The object should be not only to take away the projectile, but also, and above all, fragments of clothing which may have been carried in with it. More than the metal itself, these débris cause complications. If the forceps extraction does not remove them, the work is only half done.

The other methods employed constitute, on the contrary, true surgical methods, permitting the accomplishment of everything which is necessary to full extraction of foreign bodies and the drainage of the lung when that is necessary.

DEPAGE ON THE OPENING UP OF GUNSHOT WOUNDS*

Dr. A. Depage, Director of the *Ambulance de l'Ocean*, devotes the first pages of his second annual report to a discussion of the treatment of gunshot wounds in general. He says:

When a gunshot wound of the soft parts by a rifle ball is found to present a punctate opening, it is rarely necessary to open it up. Such a wound track heals, as a rule, spontaneously without provoking any complication. Exception should be made to wounds produced by bullets received close to the muzzle or at a short distance; such wounds demand opening up. The projectile determines almost always in such cases the shattering of the tissues, a real explosive effect, having an area of disturbance more or less deep, prone to necrosis. In such cases it would be unwise to refrain from intervention. Again, a wound should be opened up when a ball has divided an important artery and an aneurysmal hæmatoma has been created. Interference in such cases should never be undertaken except by an experienced surgeon. Ligature of the two ends of the vessel should be made, or arteriorrhaphy if coaptation is possible. When a large artery is divided and the life of the limb is in danger, the operator should avail himself of the paraffined tube of Tuffier.

Division of the large nerve trunks also calls for immediate opening up of the wound. It is impossible to insist too strongly upon the importance of examining a patient upon his reception at the hospital as to motor and sensation function in the territory of the nerve supposed to have been wounded. The course to be pursued is the exposure of the nerve, the suture of its refreshed ends and the imbedding of the sutured trunk in the neighboring muscular tissue.

Fractures by rifle balls as a rule do not demand to be opened up. The operative indication depends much more upon complications, such as have just been mentioned, than upon the fracture itself.

Wounds by Artillery Projectiles.—Here the conditions are not the same. The wounds sustained by fragments of shells or of shrapnel are much more grave and are always infected. Should, however, the small fragments not exceed in size the volume of a millet seed or of an oat grain, they may be abandoned in the soft parts, especially if they are multiple in number. Every projectile of large dimensions should be extracted. The treatment of the wound will vary according to whether the lesions involved are superficial or deep.

Subcutaneous tracks, comparatively little soiled, may not imperatively demand opening up. However, it is much better to do so, because of the frequent presence in the track of particles of clothing carrying infection. If circumstances permit it, the thing to do is to extirpate the track *en masse* through sound tissue and make immediate suture. If the wound presents only a point of entry into a subcutaneous track, the extraction of the projectile

* Ambulance de l'Ocean, La Panne. Travaux publiés sous la Direction du Dr. A. Depage.

is to be effected. However, if the depth of the subcutaneous track does not exceed from 2 to 3 centimetres, it is not necessary to open up, for the foreign body with the clothing débris may be extracted by means of a simple curette. If the track is longer, there is no further discussion as to the necessity of opening up in all cases.

By free opening of the injured area decompression of the tissues bound down by aponeurotic sheaths is effected and the escape of secretions favored. The surgeon seeks to protect the patient from septic complications and to put the wound in the most favorable conditions for cicatrization and for suture. To realize this double end, it is necessary to remove from the wound not only the foreign bodies soiled by microörganisms (projectiles, débris of clothing, etc.) but also the devitalized tissue, such as flesh, contused, necrotic—a condition favorable for microbic growth. It should be noted that the zone of injury, of cell depression, is not limited to the tissues which come in direct contact with the projectile, but extends from a half to a whole centimetre beyond, even to the depth of 2 centimetres. The vitality of these tissues is involved and there is every advantage in removing them from contact with the elements less involved, or even unaltered. It is often the early period at which the first intervention is done and the minuteness with which it has been practised that determines the later progress of the wound and the possibility of rapid repair.

The Operative Technic.—Some surgeons have recommended to take away the traumatized area *en bloc,* as one would take away a tumor. The length, the depth and the direction of the track being exactly marked out by the use of a metal sound and the wound being perfectly isolated from the operative field, they carry around the orifice an oval incision whose main axis corresponds to the direction of the wound track. They divide successively the skin, the connective tissue, the aponeurosis and the muscles, keeping constantly in healthy tissue so as to carve out a mass which includes the track in its totality. Thus, they take away *en masse* all the injured tissue, taking care, meanwhile, to keep the healthy track protected from contamination. Immediate suture is then done. Such a complete operation would constitute without doubt an ideal mode of intervention, if the traumatic areas were always regularly delimited and if one could cut into the flesh without any anxiety as to the organs which were enclosed. But such conditions, it is hardly necessary to say, are never realized when one has to do with lesions extensive and deep, so that the method described can be reserved only for short and superficial tracks.

The only truly rational procedure consists in the wide opening up of the foyer, as is practised by the great majority of surgeons.

Before proceeding to the opening up, the surgeon should picture to himself as exactly as possible the configuration of the track through the different anatomical planes. In the case of through-and-through wounds the apertures of entrance and of exit are to be noted. In the case of wounds with one orifice of entry only the topographical situation of the projectile should be

determined by the X-ray or by the electro-vibratory apparatus. After the general plan of the track has been laid out, the incision should be planned so as to permit complete access to the wound without producing new anatomical injuries. The direction of the incision should vary according to the region wounded and the nature of the wound.

In the arm, forearm and lower third of the leg transverse incisions should be refrained from, because they endanger the section of important organs. Longitudinal incisions alone are admissible; whether one has to do with a lesion presenting a single lodging point, or whether an anterior and a posterior point require simultaneous attention. These incisions should always be sufficient to permit a complete opening up of the track.

A wound involving the front of the leg calls equally for a longitudinal incision, with the exception, that in the upper third a wound of the anterior tibial artery may demand a transverse section of the muscle.

In the thigh, anteriorly and posteriorly, in the popliteal space, and in the calf of the leg, through-and-through wounds and simple penetrating wounds should in general be approached by incisions parallel to the axis of the limb. Transverse incision in these cases does not offer any advantage and is likely to occasion extremely serious injuries. Two longitudinal incisions, the one anteriorly and the other posteriorly, will always permit the thorough opening up of the foyer.

In cases where the muscular masses are too thick to permit access to the deep parts of the track by longitudinal incision only, cases in which very free opening up is necessary throughout the whole depth of the wound in order to provide against the accidents of gaseous infection, it will often be necessary to resort to transverse incision, dividing the muscles or part of the muscles interposed between the surface of the skin and the deep track. In wounds of the anterior face of the thigh, one will have to incise the anterior rectus, the vastus externus and sometimes the tensor fascia lata; on the posterior face, the biceps and the semimembranosus; in the calf, the gastrocnemius, and in the posterior face of the arm, the triceps. Such transverse sections should involve only the muscles and the aponeuroses, avoiding the nerves and the blood-vessels.

At the end of the procedure it is important, when possible, to reëstablish the continuity of the divided muscles by suturing with catgut and by partial suture of the aponeurosis and the skin.

Transverse section thus done should leave behind no loss of function, provided, of course, that the suture holds. If doubt exists as to the full cleanliness of the deep wound, the suture of the divided muscles may be postponed for two or three days, when the surgeon can have assurance as to the nature and degree of the final infection. In some circumstances when the opening up has been resorted to very late, or there already exists a deep infection, immediate suture of the muscle ends must be refrained from.

Excision of the Tissues.—If a superficial track is to be dealt with, the free edges of the orifices should be resected, and these should be united by

dividing the bridge of intervening tissue so as to transform the track into a groove. Then, with the aid of strong scissors the injured tissues which carpet the sides and the path of the groove are completely cut away.

In case of a blind wound, or a deep through-and-through track, the first step, likewise, should be the resection of the free edges of the orifices of entry and exit to the depth of from 1 to 2 centimetres, circumscribing each of these orifices by an elliptical incision.

Each incision is enlarged until the foyer is opened up from one or both directions, according to whether there is or is not an orifice of exit. The superficial aponeurosis is incised to the same extent as the skin. Pursuing the track further into the depths of the tissues, a director should be introduced into the wound, using one which will separate easily the muscular fasciculi. The best means of reaching the foyer is to raise up with two forceps the edges of the muscle in following the track and resecting the contused parts layer by layer. If at any moment the track is lost, which often happens in the deep parts, the gloved finger introduced into the wound finds it again without difficulty. It is important to note that the divided muscles retract, and when this has taken place the ends should be sought out in order to excise the contused parts.

The injured muscle tissue should be resected throughout the whole face of the wound down to healthy tissue. This is recognized by its contractility and its red tint, which contrasts with the dull color of the contused muscle.

When the projectile has been reached by this process of approach, it is removed together with fragments of clothing. After the foyer has been widely exposed, it is best to irrigate the wound with Dakin fluid or preferably with warm physiological serum which improves the appearance of the contused and injured parts.

In case of fracture, the question of the removal of splinters of bone has often been discussed. Surgeons have not reached accord as to this point. Some find that it is better to take away all splinters by a subperiosteal method; others abstain from any splinter removal, or take away only the splinters lying free in the foyer. The problem is, indeed, difficult to resolve and it will be only with time and experience that our ideas will become fixed. Our own practice is as follows: If the wound is such that an immediate suture can be attempted, we take away the splinters that are free, taking care always to leave the osseous bridge between the fragments. If, on the other hand, it is plain that the suture cannot be done by reason of the extent of the injury, we no longer take away any splinter in the course of the operation, thinking that it is better to allow to be spontaneously thrown off, as the process of granulation progresses, the splinters which become necrotic. This last method of procedure offers the great advantage of lessening the dangers of a pseudo-arthrosis and of notably shortening the primary operation, an item which should be taken into account when dealing with a severe fracture in a patient who is in a state of shock.

Suture of Wounds.—When a gunshot wound is opened up, in order to

prevent the development of infection, one should seek at the same time to put the wound into conditions most favorable for suture.

This may be done immediately after the incision—immediate suture—or after five or six days—delayed primary suture—in which case it is done as the immediate suture, without refreshing, by simply bringing into apposition the wound surfaces. Lastly, suture can be done after chemical sterilization of the wound, secondary suture. This is done after the eighth day, when the wound has become covered with granulations which necessitate always the refreshing of the wound surfaces, and it is this which distinguishes it from the preceding sutures.

As to the indications for these various methods of suture, the following are formulated:

(*A*) *Immediate Suture.*—Indications vary according to the region wounded. For wounds of the joints immediate suture is imperative, excepting in the presence of very extensive osseous lesions.

In wounds of the cranium, of the face, of the feet, of the hands, the rich vascular supply, both bloody and lymphatic, permits the surgeon to make immediate suture in a systematic way.

As to wounds of the soft parts and in case of fractures, the indications for immediate suture are very relative, although surgeons are coming more and more commonly to practise it. It may be done any time within twelve hours after the wound, but only when the surgeon can continue to watch over his patient for at least fifteen days. It offers as an advantage the complete anatomical repair of the wounded tissues, but the infections which may disturb are often rapid and severe, such as diffuse phlegmonous infections and gaseous gangrene.

(*B*) *Delayed Primary Suture.*—This is adapted particularly for wounds of the soft parts and open fractures. It may be made if bacteriological control shows its propriety. As practised by us it is as follows:

At the first dressing, 12 to 24 hours after the opening up of the wound, a smear is taken for immediate examination and the secretion is submitted also to culture.

At the second dressing, 36 to 48 hours after the opening up, a new smear is taken. If the culture of the first smear does not reveal streptococci, and if the microbial count does not exceed one microbe in two fields, suture is practised.

We never suture if the count at the second dressing shows an increasing microbial growth, even if the microbes are not pathogenic. Delayed primary suture rarely fails on account of grave later complications. It only offers the slight inconvenience of two operations.

(*C*) *Secondary Suture.*—This is reserved for wounds which cannot be sutured during the first days because of too extensive destruction of tissue, or because of a threatening infection. It presents the great advantage of giving complete safety, but delays the healing and never gives as complete an anatomical restoration as do the primary sutures.

We practise it regularly when the microbial growth is maintained at a point of less than one microbe in four fields at two successive examinations, and when the culture is free from streptococci. Although experimentally we had sometimes resorted to suture in the presence of streptococcus, the deplorable results obtained in such cases have caused us to finally establish rules quite precise as to the indications and contra-indications of secondary suture.

The following table gives the statistics of sutures done in the Hospital de l'Ocean, from May, 1916, to November, 1917. The failures are due in most part to the presence of streptococci in the wound.

	Total	Complete Success	Partial Success	Unsuccessful
		Per Cent.	*Per Cent.*	*Per Cent.*
1. Immediate suture:				
Cranium, face, hands, feet	491	473–96.3	8– 1.6	10– 2.1
Large joints: without osseous lesion	66	62–95.9	.....	4– 6.1
With osseous lesion	79	71–89.8	1– 1.2	7– 9
Soft parts	380	319–83.9	24– 6.3	39– 9.8
Fractures: Femur	4	4–100	.....	.....
Other bones	26	20–76.9	3–11.34	3–11.54
2. Delayed primary suture:				
Cranium, face, hands, feet	18	18–100	.....	.....
Soft parts	222	207–93.2	8– 3.6	7– 3.2
Fractures: Femur				
Other bones	20	16–80	4–20	.....
3. Secondary suture:				
Cranium, face, hands, feet	64	58–90.6	4– 6.2	2– 3.2
Soft parts	845	724–85.6	70– 8	51– 6.4
Fractures: Femur	39	30–76.9	7–17.9	2– 5.2
Other bones	102	92–90	3– 3	7– 7

TREATMENT OF WOUNDS OF THE FOOT *

Dr. A. De Page and Dr. L. Delrez present as the second paper in tome 2, fascicle 1, of the scientific reports of the Ambulance de l'Ocean (La Panne, Belgium), the results of their work with wounds of the feet.

I. *Skin Wounds.*—Losses of substance from the skin of the foot are very difficult to repair. They result from a traumatism which has torn off and destroyed a flap of skin, or are consecutive to the retraction of the borders of a wound which it has been impossible to suture immediately. The retractibility of the skin of the foot and of the regions below and behind the malleoli is very marked, the divided edges separate from each other, turn back and very quickly become attached to the bone. Simple linear wounds of however small extent and however slight the detachment of their edges, often leave granulating surfaces which prevent complete apposition.

In most cases we have to leave these granulating surfaces to healing by a second intention, to a spontaneous epidermization which always gives an adherent cicatrix with all its inconveniences. Plastic operations do not offer any help here; there is no sliding possible. At most, when the situation permits it, one can utilize the skin of a toe to cover a granulating wound. More serious still are losses of substance from the sole of the foot and from the heel. The skin in these regions presents special characteristics which are indispensable to enable it to support the weight of the body. The cicatrix resulting by second intention at this level interferes much with walking. On account of these considerations, the following conclusions are formulated:

The greatest parsimony should be exercised in making excisions of contused skin, either on the dorsum or on the sole of the foot. The scissors or the scalpel should take away the least amount of skin possible and this minimum should be confined to the immediate edges of the wound. The well-nourished skin of the foot can reëstablish itself more easily than can the fleshy parts of the member.

To escape the immediate and later inconveniences of healing by second intention, it is important to practise to the fullest degree possible immediate sutures of wounds of the feet, whether they involve the soft parts or skeleton.

In cases where the immediate suture appears dangerous, it is necessary without waiting for the wound to become sterile, to proceed at an early time to at least a secondary suture, even though it may be partial, in order to prevent retraction of the edges and further adhesions to the underlying tissues.

The application of these principles may lead to immediate suture in most cases. Happily, the blood and lymph supply of the foot is very rich and inflammatory accidents are the exception.

Lacerated and contused wounds of small size may easily be sutured, but large wounds are more difficult.

* Ambulance de l'Ocean, La Panne. Tome 2. fascicle 1. p. 9.

Sometimes the traumatism has produced a true scalping of the foot, the skin is torn and often rolled up as far as the middle of the sole. In such a case we cut away a strip of the skin and of the subcutaneous connective tissue. We examine the wound carefully and we practice the suture of the flap without drainage. To favor the reëstablishment of the circulation, it has appeared to us useful to practice numerous scarifications of the free edge if cyanosed. These scarifications permit the venous blood to flow out and empty the capillary system of the flap and facilitate the reëstablishment of the circulation in parts menaced by gangrene.

The fear of severe infection in important injuries of the foot, or the necessity of rapidly terminating an operation on account of the general state of the patient, sometimes obliges the surgeon to give up attempts at immediate suture. In such cases as soon as circumstances permit it he should make always a total or partial secondary suture without waiting for surgical sterility of the wound. Incomplete secondary sutures of wounds of the foot, non-sterile, as a rule are not followed by accidents.

Autoplastic Grafts.—Losses of substance resulting in the tearing off or destruction of a portion of the skin of the foot give rise to most serious difficulties. On the sole they are physiologically beyond repair; one is compelled to abandon such a wound to secondary cicatrization which always gives a defective result, or one has to deliberately sacrifice a part of the bony framework.

Losses of substance seated on the dorsum of the foot may be repaired, either by making use of the skin of a toe disarticulated for that purpose, or by having recourse to autoplasty.

We call *greffe en cascade* an autoplasty which we have practised with success and which consists in taking a flap at a distance from the wound. At the first step this flap is twisted upon its pedicle and fixed by its border nearest the wound. At the second step the pedicle is divided and the flap is submitted to a second twisting which brings its bloody surface over the wound.

In wounds of the sole of the foot involving the soft parts only, it is necessary to avoid as far as possible large incisions, with the view of preserving to the skin all its properties. The incision should be preferably transverse in the posterior region, and in the middle of the foot they should be longitudinal in the anterior region.

Wounds of Tendons.—Those of the tendon Achilles are the most important. Their gravity is realized above all when the tendon is completely cut through and is followed by retraction of the triceps of the calf. They are in general complications of a lesion of the heel and of the posterior portion of the os calcis.

These wounds, above all when they are the result of an artillery projectile, should always be opened up and the surgeon should explore and refresh the tendinous insertions sufficiently to reëstablish the continuity of the tendon. If the insertions are completely detached, the thing to do is to reëstablish them as far as possible. If the tuberosity of the os calcis is

entirely destroyed, one can fix the tendon to the periosteum if it has been sufficiently preserved, or to the plantar aponeurosis. Immediate suture is of advantage in all cases. If it has not been possible to do it for any reason whatever, secondary suture should be applied as early as possible.

Finally, when the fixation of the tendon Achilles cannot be realized, one should never lose sight of the fact that by its elongation the functional mobility of the foot may be restored. The lesions of the extensors and the anterior tibial do not present any complications. Suture is generally done to restore their continuity. Those of the peroneals are more difficult to treat, not in consequence of retraction, which is never an obstacle to the suture, but because of the destruction of the tendinous sheath which is impossible to restore to its natural state by suture. Most of the time the sutured tendons have to be left in a tendinous gutter and remain there in contact with raw tissue. It is interesting to note that such little favorable conditions in general do not leave permanent trouble as far as the ulterior function of these tendons is concerned, contrary to what is observed in the hand.

Infections of the tendinous sheaths of the lateral peroneals at the neck of the foot as a rule lead to progressive phlegmons which on one side ascend to the external aspect of the leg and on the other gain the sole of the foot. Such phlegmons are complicated, besides, generally with inflammatory lesions of the tarsal bones.

Lesions of the Bony Framework and of the Joints.—These wounds often result in important mutilations.

The most simple case is a fracture of one or two metatarsal bones, the projectile remaining imbedded in the tissues. The operative interference consists in excising the injured edges of the orifice of entrance and the bruised soft parts and in making a very careful removal of the bony splinters, even to the extent of subperiosteal resection with a toilet of the bony ends. The projectile is removed in the course of the operation and the whole procedure is terminated by immediate suture. When the orifice of entrance is seated on the dorsum of the foot, as is most frequent, we avoid any incision on the plantar surface unless the foreign body projects under the skin. An extensive loss of substance in the neighborhood of the head of the metatarsal may require the removal of the corresponding toe. When the first or the fifth metatarsal bone is involved, a transverse incision is practised to expose freely the fracture and to facilitate the removal of fragments. A through and through wound of the metatarsus should be treated in the same way. Too often the surgeon is tempted to be conservative. It is an exception to see a fracture of the metatarsus heal spontaneously without accidents of infection.

In wounds by projectiles of large size, the injuries are more important and involve generally several metatarsal bones. These bony injuries require resection or disarticulation of the injured metatarsal bones with removal of the corresponding toes. Lesions of the borders of the foot are *a priori*, more severe because they compromise the foot as a means of support.

The surgeon should be sparing in making resections of the metatarsal bones; in fact, the fifth metatarsal represents, as we have seen, an essential part of the anterior arch of the foot, and the first metatarsal with the great toe constitutes also an important point of support. We have always observed very satisfactory results from amputation following the internal and external borders of the foot. In both cases, the upright position and the walk remain easy, though running and leaping are seriously hindered, less, however, than after the disarticulation of Lisfranc.

Transverse penetrating wounds with fracture of several of the metatarsal bones should be treated on the same general principle as isolated fractures. The wound should be opened up by resection of the two orifices, followed by a transverse incision connecting them, which permits the injured bones to be reached easily.

Finally, in very extensive destructions of the metatarsus and of the toes, the only resource is the disarticulation of Lisfranc, which furnishes a very good stump. Walking, even for a long time, is easy and without fatigue. Running only is prevented.

Wounds of the Tarsus.—Wounds of the anterior or posterior tarsus may be divided into two classes: first, wounds from artillery projectiles of small size which involve only bony and articular disturbances of slight importance; second, the great injuries of the bones and joints produced by voluminous fragments by which one or many bones are shattered and corresponding articulations opened up.

The treatment of wounds by small projectiles does not differ from that which is required by wounds in general and those of the metatarsus in particular. Free opening up is essential with excision of all the contused parts. Osseous tunnels should be cleaned out with the greatest care. As far as possible, the operation should be terminated by immediate suture without drainage, or with filiform drainage. Most frequently such wounds heal without complication.

Wounds by voluminous projectiles may in some cases be well handled by a free opening up and by removal of bony fragments with an attempt at primary suture, especially when one has to do with lesions involving the anterior portion of the tarsus; injuries of the cuneiform bone, the scaphoid and cuboid; one may sometimes arrive at the same result in isolated lesions of the astragalus and of the calcaneum.

Removal of the astragalus, followed by immediate suture, is an operation much to be recommended. But when destruction of the posterior tarsus exceeds certain limits, it is better to make outright a supramalleolar amputation.

Large infected wounds of the tarsus always constitute grave lesions.

The complexity of the joint surfaces which ramify between the different bones renders drainage difficult, often inefficient. Suppuration persists in the foyer; it often invades the tendinous sheaths and leads to the formation of pus pockets about the malleoli and in the leg. The general state is greatly attacked and more than once we have seen the blood become involved in the infection.

The final result of these shatterings of the tarsus treated by conservative method is often very little encouraging. The bony destruction produced by the traumatism aggravated by the suppuration often leaves upon the tarsus a large cicatricial area which lends itself badly to support and offers no flexibility to the walk. So we have come to the practice in these cases, at least for the anterior tarsus, of making an atypical transverse resection. This operation is not regulated by any fixed point as a guide, it is only determined by the particular characters of the bone and joint lesion. Two transverse saw cuts are made and the entire bony mass between the cuts is taken away, preserving the plantar surface of the foot. The front of the foot is united to the tarsus by an immediate metallic suture, or if infection is to be feared, by a secondary suture made after the wound has become sterile. The preservation of the front of the foot is very useful, it helps in maintaining the standing function of the foot by preventing the astragalus from becoming rotated as occurs after the operation of Chopart. Besides, as the tibio tarsal and subastragaloid articulations are preserved, the foot maintains its mobility. Owing to these two factors the walk preserves its flexibility, which is not so in cases of the Chopart and Pirogoff operations. The results of amputations and disarticulations of the tarsus by the method of Chopart, Pirogoff, Malgaigne and Syme are alike as regards function. We have rarely had occasion to practice them in the course of the war. The Pirogoff has given us good stumps. As to our disarticulation, after the method of Chopart, we know the final result only in one case. The operation completed by transverse division of the tendo-Achillis has left a quite useful stump, although slightly retracted. The division of the tendo-Achillis is not sufficient to hinder a stump from sliding downward and forward. We believe that it becomes turned for two reasons: first, because the posterior arch of the foot being no longer supported falls, and more especially because the astragalus under the pressure of the tibia becomes rotated forward.

Simple wounds of the *tibio tarsal articulation* are to be subjected to the same treatment as articular wounds in general, free opening up, excision of the contused tissues, extraction of the projectile, toilet of the synovial membrane, immediate suture. Functional restitution is complete and rapid, especially when the operation has been followed by early mobilization. The

greater the bony lesion, the more uncertain is the result. It must be left to the experience of the surgeon to determine those lesions in which it is impossible to practise conservation and suture. We have been able, among other cases, to obtain very good results in cases where one of the malleoli or one of the borders of the tibial mortice has been shattered. In cases where intra-articular shattering of the astragalus has occurred, the removal of the astragalus appears to us to be always indicated, but in order that this operation should leave any mobility to the foot, it is necessary that an immediate suture should be practised. In cases in which suppuration has taken place every precaution must be taken necessary to prevent the development of an equinus. For the large lesions of the posterior tarsus, that is to say, where both the astragalus and the cacaneum together have been shattered, preservation should not be attempted in most cases. It exposes the patient to serious peril, while the functional results are absolutely bad.

In cases of severe wounds involving the bone and joints at the neck of the foot, we have been brought to follow the removal of the astragalus by a provisional turning back of the foot so as to permit the rapid and full disinfection of the articular surface which has been infected, and to prevent the retention of pus. The tibiotarsal articulations are widely opened on the two sides, sometimes on the external side only, and the foot is reversed either forward or inward, and held in this position by means of a bandage until complete disinfection has been accomplished. When the wound has been proven to be sufficiently sterile, the foot is brought back into good position and fixed by points of metallic suture. The final result of such an operation is satisfactory.

The tendency to equinus following a cicatricial retraction of the triceps of the calf, or loss of substance, requires elongation of the tendon of Achilles. Preventive measures are more important from this standpoint than curative, so the surgeon should take the greatest pains in wounds of the ankle to hold the foot at a right angle with the leg. The same should be said of the true equinus resulting from consolidation in a vicious position of the forefoot upon the tarsus, and more frequently of the anterior tarsus upon the posterior tarsus. Here again preventive treatment is more important than reparative treatment. Nevertheless, the process of cicatrization, notwithstanding the means used to prevent, may sometimes result in an equinus which must be remedied. In such cases most frequently cuneiform resection of the tarsus should be done. The operation consists in taking away from the tarsus a slice or a bony wedge extending to the soft parts of the plantar surface. The two cut surfaces are then brought together and held by metallic thread, followed by immediate suture of the operative wound.

Irreparable destruction of the muscles of the anterior face of the leg, or of their tendons, leads equally to the development of equinus. In a case of this kind correction has been obtained by transplanting the tendons of the flexor longus of the great toe and of the peroneus longus on the other side of the foot. These muscles were divided at the level of the malleoli; their central ends were then brought to the anterior face of the leg and implanted into the peripheral ends of the tendons of the extensors and the anterior tibial, freed from the cicatricial mass in which they were engulfed.

Mobilization in Wounds of the Foot.—As a principle, there is much advantage in early mobilization of the foot. Long rest in bed leads always to muscular atrophy, articular stiffness, vicious positions and particularly to the equinus which in the majority of cases can be prevented by ordering the wounded man to arise as soon as his lesion will permit and directing appropriate movements. If the physician himself directs this reëducation, inspires confidence in the patient, criticizes his errors and methodically graduates the mobilization, surprising results can be arrived at. It should be noted, however, that early walking should be permitted only in cases where the important points of pressure have been preserved and where the solidity of the arch runs no risk of being compromised.

BOOK REVIEWS

AMBULANCE DE L'OCEAN, La Panne, Belgium. Scientific contributions published under the direction of Dr. A. DE PAGE, with the collaboration of Dr. A. P. DUSTIN and Dr. G. DEBAISIEUX, and of the physicians of the Hospital. Volume 2, Fasciculus 1, octavo, 352 pages, Masson & Co. Paris.

This attractive volume is a report of the work done at the Belgian army hospital at La Panne, under the direction of Dr. De Page. In the first volume, which appeared a year ago, a detailed description of the hospital and its methods of work was given. In the present volume the numerous articles contained in it constitute a review of the different branches of military medicine and surgery exemplified in the work of the hospital. The largest part is given up to experimental research and to the scientific control of various methods of treatment. This work is all the more notable since it has been carried on in close proximity to the battle line and in the midst of difficulties of every kind, of which bombardment was not the least.

Of the articles contained in this volume we present in the Department of Editorial Comment a very full resumé of memoirs: Article 1, by DR. A. DE PAGE, *Le debridement des plaies de guerre;* Article 2, by DRS. DE PAGE and DELREZ, *Le traitement des plaies du pied;* Article 5, by DR. CHARLES JANSSEN, *Le cranioplastie ses indications et sa technique,* and Article 9, by DR. E. S. HARDE, *Frequence du bacille du tetanos.*

The volume as a whole is a valuable contribution to medical literature and to the records of scientific research, and demonstrates the possibilities of scientific enthusiasm added to methodical industry, even under most unfavorable circumstances. We hope that it may be the harbinger of many similar publications in the immediate future which may present to the surgical profession the riches which the experience of the four years of warfare has accumulated in the hospitals of the Allied forces.

OXFORD LOOSE-LEAF SURGERY. By various authors. Edited by F. F. BURGHARD, Lecturer on Surgery, King's College Hospital, London, and ALLEN B. KANAVEL, Associate Professor of Surgery, Northwestern University Medical School, of Chicago. In five volumes. Volume I, 1918. New York. Oxford University Press. Octavo, buckram, loose-leaf, 971 pages.

The publishers present to the profession a novelty in book-making, a book in which the cover is fastened to the main body of the volume by a mehcanism which makes it possible to remove the covers and insert additional leaves. Special attention is called to this feature of this particular book. It will be of interest to see whether actual experience shall prove that practically it presents any marked advantage. The volume now before us is one of nearly a thousand pages of supercalendered paper abundantly illustrated and forming a volume quite as large as can be conveniently handled. Should any additions or changes in the chapters included in such a volume be desired, as will certainly be the case, it is probable that they will still have to be incorporated in supplementary volumes notwithstanding this loose-leaf mechanism. This, however, in no wise has to do with the originality and individuality which the main body of the volume presents.

The attention of future medical bibliophile, in looking over the list of contributions to the present volume, will be attracted by the fact that so many of them present military titles indicative of their active participation in military work. This first volume appears while the whole world is rejoicing in the end of the great war and when the dawn of permanent and universal peace has apparently already made its appearance, so that it is profoundly to be hoped that much of the discussions and special methods demanded by the special conditions, which have attended the wounds of the last four years sustained in the battlefields of Belgium and France, will no longer have any important relation, but will remain as matters of historical interest only.

The present set of volumes is a development of the " Manual of Surgical Treatment," by Cheyne and Burghard, the scope and character of which have received repeated notice in reviews in this journal as the volumes have appeared from time to time. To this, however, have been added various contributions from American clinics and such revisions as have been called for by the development in surgical practice produced by experience in war.

It is quite evident that the attempt of the authors has been to confine its contents to procedures which are of actual present importance.

The volume is especially to be commended for its typographical qualities, the size of the type and its general manner of composition are such as to make it easy to read even by the tired eyes of a senior surgeon, while the illustrations are exceedingly well done. It is, indeed, difficult to select from among the large number of illustrations any group for particular mention, but those which illustrate the various forms of amputations practiced upon the foot are a fair sample.

One who desires to acquaint himself with the newer surgery will be especially interested in the chapter by Major Penhallow, of the Massachusetts National Guard, on the Treatment of Infected Wounds by the Carrel Method, and by that of Dr. Percy, of Chicago, and Lewisohn, of New York, on Blood Transfusion. Every department, however, is thoroughly up to date and, if the present volume is an indication of those which are to follow, it will be a series of volumes that no active surgeon can afford to be without.

THYROID AND THYMUS. By ANDRÈ CROTTI, M.D., of Columbus, Ohio. Large octavo; pages 567; profusely illustrated. Philadelphia and New York: Lea & Febiger, 1918.

This is an intensive study in goitre pathology and surgery; a monograph which has had its origin in an enthusiastic devotion to its subject. In it are embodied the results of experiences and observations made in the laboratory of Stilling of Lausanne, and in the clinic of Kocher in Berne. In a very considerable degree it may be accepted as a presentation of the teachings of those masters.

The typographical setting of the monograph is most attractive and the large number of illustrations form a marked feature of the book. The anatomical drawings, many of them in color, are by Marcel Guelin.

The anatomy, physiology, biological chemistry and pathology of the thyroid each have their respective chapters. Every aspect of goitre is elaborately studied. It evidently has been the author's plan to make his study a full record of everything of value which has been contributed to the subject by any worker anywhere. The French, Italian and German literature have been thoroughly sifted.

The presentation of the result of this study is by no means a dry and

elaborate citation of quotations; but everything has been happily transformed in the alembic of the author's own mind into a clear, interesting and connected presentation of his conclusions.

We are glad to have this full and complete study of the thyroid and thymus to place upon our shelf as a book of reference.

UNITED STATES ARMY X-RAY MANUAL. Authorized by the Surgeon-General of the Army. Prepared under the direction of the Division of Röntgenology. 12mo, flexible covers, 506 pages. New York: Paul B. Hoeber, 1918.

This manual is one of many publications which have emanated from the office of the Surgeon-General of the Army since the entrance of the United States into the great war, results of the comprehensive plans laid to secure the highest possible efficiency for the Medical Department of the Army: plans which are worthy of the highest commendation and which have played a very large part in securing the extraordinary immunity from disease which has marked the history of the American Expeditionary Force in France, and the ideal results in the treatment of the wounded which its statistics demonstrate. The manual under review is intended as a guide to röntgenologists who are doing the X-ray work in the United States military hospitals, and as a text-book of instruction in military röntgenology. The elaborateness and completeness of the X-ray plants which have been placed in all the base hospitals and in many of the evacuating stations have been a marked element in the hospital administration of this government and have been an important element in securing the successful results noted.

The importance of a book of this kind for training and guiding the work of the large number of röntgenologists required for the work of our army hospitals is self-evident. Into this work there must have been commandeered many men who had little or no previous experience in that class of work. In preparing such men for their work, and as a book of reference in their later active work, this manual will be of very great value. Particularly in the department of the localization of foreign bodies does the work of the röntgenologist assume importance in the hospitals upon the advanced line.

The chapters in this manual devoted to fluoroscopy and to the best apparatus for the localization of foreign bodies are especially worthy of

remark. The chapters devoted to bones and joints also are clear and of especial importance in acute military surgery.

The X-ray has established itself as an important auxiliary in all surgery and in general medicine. While the present manual will be placed in the hands of all surgeons holding commissions from the government, it is equally valuable to the general surgeon in civil practice in assisting him in securing the best results in the ordinary surgery of civil life.

To Contributors and Subscribers:

All contributions for Publication, Books for Review, and Exchanges should be sent to the Editorial Office, 145 Gates Ave., Brooklyn, N. Y.

Remittances for Subscriptions and Advertising and all business communications should be addressed to the

ANNALS *of* SURGERY
227-231 S. 6th Street
Philadelphia, Penna.